ARF-020948

Savannah River
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# Fifth Five-Year Remedy Review Report for Savannah River Site Operable Units with Groundwater Remedies (U)

## Aiken, South Carolina

**SRNS-RP-2015-00419**

**Revision 1**

**July 2016**



SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

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## EXECUTIVE SUMMARY

This document presents the results of a technical evaluation of seven environmental remedies that implemented groundwater remediation at Savannah River Site (SRS). The remedies are evaluated to determine whether they are functioning as designed and whether they are protective of human health and the environment. This evaluation is required under Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986. CERCLA requires that remedial actions that result in any hazardous substances, pollutants, or contaminant remaining at the site be subject to a remedy review every five years.

Previous five-year remedy review reports combined all SRS operable units (OUs) that had implemented a remedial action into a single document. A recommendation was made by SRS in the Fourth Five-Year Remedy Review Report that future reviews should be conducted in phases based on OU groupings with similar remedies. This phased approach not only reduces the volume of future remedy reports, but also is more effective in identifying and resolving issues for similar remedies. For this reason, the Fifth Five-Year Remedy Review Report will be conducted in five phases. This report presents the second phased review for seven SRS OUs that selected groundwater remediation as the final remedy. More specifically, the seven SRS OUs evaluated in this report were grouped together because of similar groundwater monitoring activities primarily associated with Monitored Natural Attenuation or a Groundwater Mixing Zone permit.

According to the data reviewed and the site inspections, the seven remedies evaluated in this report are functioning as intended. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection are still valid. No new information has come to light that calls into question the protectiveness of any of the remedies evaluated. The seven remedies have been determined to be protective of human health and the environment.

This report presents the issues and recommendations that have resulted from the remedy review. SRS identified the following recommendation:

- Monitoring for 1,4-dioxane at the D-Area Oil Seepage Basin OU and the R-Area OU is recommended. This constituent is a potential contaminant at the two OUs based on its association with other solvents present. SRS will report the results in the appropriate OU-specific groundwater monitoring reports. Based on the monitoring results, the U.S. Environmental Protection Agency, South Carolina Department of Health and Environmental Control, and the U.S. Department of Energy will determine whether or not 1,4-dioxane should be permanently added to the list of monitored constituents for the two OUs.

# Five-Year Review Summary Form

| **SITE IDENTIFICATION** | | | | |
|---|---|---|---|---|
| **Site Name:** Savannah River Site | | | | |
| **EPA ID:** SC1890008989 | | | | |
| **Region:** **4** | **State: SC** | **City/County:** Aiken/Aiken | | |
| **SITE STATUS** | | | | |
| **NPL Status:** Final | | | | |
| **Multiple OUs?:** Yes | **Has the Site achieved Construction Completion?:** No | | | |
| **REVIEW STATUS** | | | | |
| **Lead Agency:** Other Federal Agency<br>**If "Other Federal Agency" was selected above, enter Agency Name:**<br>U.S. Department of Energy | | | | |
| **Author Name (Federal or State Project Manager:** N/A | | | | |
| **Author Affiliation:** Savannah River Nuclear Solutions, LLC | | | | |
| **Review Period:** May 12, 2015 – January 21, 2017 (Phase 2: SRS OUs with Groundwater Remedies) | | | | |
| **Date of Site Inspections:** August 2015 - November 2015 (Phase 2: SRS OUs with Groundwater Remedies) | | | | |
| **Type of Review:** Statutory | | | | |
| **Review Number:** 5 | | | | |
| **Triggering Action Date:** January 21, 2014 | | | | |
| **Due Date (Five Years after Triggering Action Date):** January 21, 2019 (includes all 5 Phases) | | | | |
| **ISSUES/RECOMMENDATIONS** | | | | |
| **OU(s) without Issues/Recommendations Identified in the Five-Year Review** | | | | |
| **CERCLIS #: 24, 25, 56, 77, 82,** | | | | |
| **Issues and Recommendations Identified in the Five-Year Review** | | | | |
| **OU(s):** 27, 95 | **Issue Category:** Monitoring | | | |
| | **Issue:** 1,4-dioxane has been identified as a potential contaminant based on its association with other solvents that are present at two OUs. However, there is a lack of groundwater data to dismiss 1,4-dioxane as being present at levels which would be harmful to human health or the environment. | | | |
| | **Recommendation:** 1,4-Dioxane will be monitored and reported as detailed in the two OU remedy review reports. Based on the monitoring results, the USEPA, SCDHEC, and USDOE will determine whether or not 1,4-dioxane should be permanently added to the list of monitored constituents. | | | |
| **Affect Current Protectiveness** | **Affect Future Protectiveness** | **Implementing Party** | **Oversight Party** | **Milestone Date** |
| No | No | Federal Facility | USEPA/SCDHEC | 2016 (RAOU);<br>2017 (DOSB OU) |

# Five-Year Review Summary Form *(continued/end)*

| PROTECTIVENESS STATEMENT(S) | | |
|---|---|---|
| ***Operable Unit:***<br>C-Area Groundwater (CAGW)<br>CERCLIS # 82 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the CAGW OU is protective of human health and the environment. | | |
| ***Operable Unit:***<br>Chemical, Metals, and Pesticides (CMP) Pits (080-17G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G), CERCLIS # 24 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the CMP Pits OU is protective of human health and the environment in the short-term. However, in order to establish long-term protectiveness, additional remedial actions may need to be evaluated and selected, as necessary, based on the results of groundwater modeling and continued groundwater and surface water monitoring. | | |
| ***Operable Unit:***<br>D-Area Oil Seepage Basin (DOSB) (631-G), CERCLIS #27 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the DOSB OU is protective of human health and the environment. | | |
| ***Operable Unit:***<br>L-Area Burning/Rubble Pit (131-L) (LBRP), Gas Cylinder Disposal Facility (131-2L) (GCDF), and L-Area Rubble Pile (131-3L) (LRP), CERCLIS #56 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the LBRP/GCDF/LRP OU is protective of human health and the environment. | | |
| ***Operable Unit:***<br>L-Area Southern Groundwater (LASG), CERCLIS #77 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the LASG OU is protective of human health and the environment. | | |
| ***Operable Unit:***<br>R-Area Operable Unit (RAOU), CERCLIS #95 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the RAOU is protective of human health and the environment. | | |
| ***Operable Unit:***<br>R-Reactor Area Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin (RRSB), CERCLIS #25 | ***Protectiveness Determination:***<br>Protective | ***Addendum Due Date (if applicable):***<br>N/A |
| ***Protectiveness Statement:***<br>The remedy at the RRSB OU is protective of human health and the environment. | | |

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| | |
|---|---|
| ac | acre |
| ARAR | applicable or relevant and appropriate requirement |
| ARRA | American Reinvestment and Recovery Act |
| bgs | below ground surface |
| BPRG | Building Preliminary Remediation Goal |
| BRA | Baseline Risk Assessment |
| CA | contamination area |
| CAGW | C-Area Groundwater |
| CBRP | C-Area Burning/Rubble Pit |
| $CCl_4$ | carbon tetrachloride |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act |
| CERCLIS | Comprehensive Environmental Response, Compensation and Liability Information System |
| CFR | Code of Federal Regulations |
| Ci | Curies |
| cDCE | cis-1,2-DCE |
| cm | centimeter |
| CM | contaminant migration |
| cm/sec and cm/s | centimeter per second |
| CMCOC | contaminant migration constituent of concern |
| CMP Pits | Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G) |
| CMS/FS | Corrective Measures Study/Feasibility Study |
| $CO_2$ | carbon dioxide |
| COC | constituent of concern |
| CPT | cone penetrometer technology |
| CRSB | C-Area Reactor Seepage Basins |
| +D | plus daughter |
| DCE | dichloroethene |
| DCM | dichloromethane |
| DDD | dichlorodiphenyldichloroethane |
| DDE | dichlorodiphenyldichloroethylene |
| DDT | dichlorodiphenyltrichloroethane |
| DO | dissolved oxygen |
| DOSB | D-Area Oil Seepage Basin (631-G) |
| DNAPL | dense non-aqueous phase liquid |
| EAROD | Early Action Record of Decision |
| EC&ACP | Environmental Compliance and Area Completion Projects |
| ECO | ecological |

## LIST OF ACRONYMS AND ABBREVIATIONS *(continued)*

| | |
|---|---|
| ECODS | Early Construction and Operational Disposal Site |
| EE/CA | Engineering Evaluation/Cost Analysis |
| EIS | Environmental Impact Statement |
| EMP | Effectiveness Monitoring Plan |
| EMR | Effectiveness Monitoring Report |
| ERH | electrical resistance heating |
| ESD | Explanation of Significant Differences |
| FFA | Federal Facility Agreement |
| FONSI | Finding of No Significant Impact |
| FY | fiscal year |
| ft | feet |
| $ft^3$ | cubic feet |
| $ft^3$/min | cubic feet per minute |
| GAU | Gordon Aquifer Unit |
| GMZA | Groundwater Mixing Zone Application |
| GWMZ | Groundwater Mixing Zone |
| ha | hectare |
| HH | human health |
| ICA | Isolated Contamination Area |
| In | inch or inches |
| IRA | interim remedial action |
| IROD | Interim Record of Decision |
| ISD | in situ decommissioning |
| km | kilometer |
| $km^2$ | square kilometer |
| LADB | L-Area Disassembly Basin |
| LAERB | L-Area Emergency Retention Basin |
| LAHS | L-Area Hot Shop |
| LAOCB | L-Area Oil and Chemical Basin |
| LASG | L-Area Southern Groundwater |
| LAZ | Lower Aquifer Zone |
| lbs | pounds |
| LBRP/GCDF/LRP | L-Area Burning/Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) |
| LLC | Limited Liability Company |
| LRSB | L-Area Reactor Seepage Basin |
| LUCAP | Land Use Controls Assurance Plan |
| LUCIP | Land Use Controls Implementation Plan |
| LUC | land use control |
| m | meter |
| $m^3$ | cubic meter |

## List of Acronyms and Abbreviations *(continued)*

| | |
|---|---|
| MCL | maximum contaminant level |
| mi | Mile |
| $mi^2$ | square miles |
| mV | milliVolt |
| µg/kg | microgram per kilogram |
| µg/L | microgram per Liter |
| mg/kg | milligrams per kilogram |
| MAZ | Middle Aquifer Zone |
| MNA | monitored natural attenuation |
| msl | mean sea level |
| MZ | mixing zone |
| MZCL | mixing zone concentration limit |
| N/A | not applicable |
| NBN | no building number |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NFA | No Further Action |
| NPL | National Priorities List |
| NTCR | non-time critical removal |
| O&M | operation and maintenance |
| ORP | oxidation reduction potential |
| OU | operable unit |
| PCE | tetrachloroethylene |
| PAR | P and R |
| PCB | polychlorinated biphenyl |
| ρCi/g | picoCuries per gram |
| ρCi/mL | picoCuries per milliliter |
| ρCi/L | picoCuries per liter |
| PCR | Post Construction Report |
| PRG | Preliminary Remediation Goal |
| PSA | Potential Source Area |
| PSL | process sewer line |
| PTSM | principal threat source material |
| RAGW | R-Area Groundwater |
| RAO | remedial action objective |
| RAOU | R Area Operable Unit |
| RCOC | refined constituent of concern |
| RCRA | Resource Conservation and Recovery Act |
| RFI | RCRA Facility Investigation |
| RG | remedial goal |
| RGO | remedial goal option |

## LIST OF ACRONYMS AND ABBREVIATIONS *(continued/end)*

| | |
|---|---|
| RI | Remedial Investigation |
| ROD | Record of Decision |
| RPSL | R-Area Process Sewer Line |
| RRSB | R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin |
| RSL | regional screening level |
| RUNK | R-Area Unknown |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |
| SCDHEC | South Carolina Department of Health and Environmental Control |
| SRL | Savannah River Laboratory |
| SRS | Savannah River Site |
| SRNS | Savannah River Nuclear Solutions, LLC |
| SVE | soil vapor extraction |
| TCE | trichloroethylene |
| TCCZ | Tan Clay Confining Zone |
| TZ | Transmissive Zone |
| USDOE | United States Department of Energy |
| USEPA | United States Environmental Protection Agency |
| UST | underground storage tanks |
| UTRA | Upper Three Runs Aquifer |
| VC | vinyl chloride |
| VOC | volatile organic compound |
| WSRC | Washington Savannah River Company |
| WSRC | Westinghouse Savannah River Company |
| yd | yards |
| $yd^3$ | cubic yards |

## SAVANNAH RIVER SITE SUMMARY

## I. INTRODUCTION

Section 121 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires that remedial actions which result in any hazardous substances, pollutants, or contaminant remaining at the site be subject to a five-year remedy review. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) further provides that remedial actions which result in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure be reviewed every five years to ensure protection of human health and the environment. The purpose of five-year remedy reviews is to evaluate the implementation and performance of the selected remedy at an operable unit (OU) to determine if the remedy is protective of human health and the environment. The evaluation of the remedy and the determination of protectiveness should be based on and sufficiently supported by data and visual inspections. The methods, findings, and conclusions of remedy reviews are documented in Five-Year Remedy Review Reports. The reports also identify any issues found during the review and provides recommendations to address the issues.

The U.S. Department of Energy (USDOE) prepared this fifth five-year remedy review for Savannah River Site (SRS) OUs that selected groundwater remediation as the remedial action pursuant to CERCLA Section 121 and as amended by SARA and the NCP. During implementation of the five-year remedy review process at the SRS, the U.S. Environmental Protection Agency (USEPA), the South Carolina Department of Health and Environmental Control (SCDHEC), and the USDOE recognized that remedial action decision document(s) would be issued for multiple OUs. Rather than generate individual five-year remedy review reports for each OU, the USDOE and regulatory agencies determined that it would be more cost effective to conduct a remedy review for all applicable OUs on the same five-year cycle. The First Five-Year Remedy Review was issued in August 1997 (WSRC 1997) and evaluated 23 remedy decision documents. The Second Five-Year Remedy Review was issued in February 2004 (WSRC 2003) and evaluated 30 remedy decision documents. Forty-five remedy decision documents were evaluated in the Third Five-Year Remedy Review issued in January 2009 (WSRC 2008). The Fourth Five-Year Remedy Review was issued in February 2014 (SRNS 2014) and evaluated 52 remedy decision documents.

The size of each report has grown considerably since 1997 due to the number of OU remedies evaluated, and the level of detail required for data reviews, site inspection reporting, and document formatting based on USEPA guidance. To allow for a more even distribution of resources, a recommendation was made by SRS in the Fourth Five-Year Remedy Review Report (SRNS 2014) that future reviews should be conducted in phases based on OU groupings with similar remedies. In addition to a reduction in the total volume for future remedy review reports, evaluating similar remedies in the same review period would support easier identification and resolution of similar issues and allow for more efficient implementation of similar initiatives. The USDOE, USEPA, and SCDHEC agreed to segregate the Fifth Five-Year Remedy Review Report into five OU groupings (grouped by remedy similarity) with a different group submitted annually on a five-year cycle. The SRS OUs are grouped by the following remedy types:

(1) Native Soil Covers and/or Land Use Controls (LUCs);

(2) Groundwater;

(3) Engineered Cover Systems;

(4) Geosynthetic or Stabilization/Solidification Cover Systems; and

(5) Operating Equipment.

The trigger date for submittal of the next five-year remedy review report to the regulatory agencies is based on the USEPA signature date of the previous report. The final signature for the last grouping of Fifth Five-Year Remedy Review Report is due no later than January 21, 2019. Prior to implementing the five annual remedy review submittals, a transitional period is necessary to prevent exceeding the five year limit required between decision document reviews in order to remain in compliance with CERCLA and the NCP. Issuance dates for the Fifth Five-Year Remedy Review Report during the transitional period will occur over a four-year period (2016 - 2019). The first five-year phased report for native soil covers and LUCs was issued in 2015 (SRNS 2015). A more detailed discussion of the phased reviews and transition schedule are provided in Appendix A.

This report documents the Fifth Five-Year Remedy Review for the second grouping of OUs with groundwater remediation selected as the final remedy and includes a review of seven remedy decision documents for seven USEPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) units at the SRS. CERCLIS is a database maintained by the USEPA as part of the Superfund program that assigns a unique tracking number to hazardous waste sites considered for cleanup under CERCLA. Remedy decision documents may include more than one CERCLIS unit and/or SRS OU. For this remedy review, the seven CERCLIS units are equivalent to the seven SRS OUs reviewed.

The seven SRS OUs evaluated in this document were grouped together because of similar groundwater monitoring activities associated with Monitored Natural Attenuation or a Groundwater Mixing Zone permit. Although the grouping is a result of the common groundwater remedies, the OUs may also have subunits with contaminants in soils or building materials (concrete and metal) that are addressed by the remedy decision document. Table 1 identifies the OU name, CERCLIS number, remedial action(s), and issuance date of the remedy decision document for each of the seven OUs reviewed in this document. The issuance date represents the date the public was notified that the signed remedy decision document was available. Figure 1 identifies the location of the seven SRS OUs evaluated in this document. The data evaluation and visual inspections for the seven SRS OUs with groundwater remedies were conducted from August 2015 through November 2015.

This report was prepared using the *Comprehensive Five-Year Review Guidance* (USEPA 2001) and is supplemented by the *Recommended Evaluation of Institutional*

*Controls: Supplement to the "Comprehensive Five-Year Review Guidance"* (USEPA 2011) and *Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews* (USEPA 2012). This report summarizes common elements for the entire SRS. The seven remedy reviews are included as Appendix C through Appendix I.

## II. SITE CHRONOLOGY

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 program with CERCLA requirements to provide for a focused environmental program. In accordance with Section 120 of CERCLA 42 United States Code Section 9620, the USDOE has negotiated a Federal Facility Agreement (FFA) (FFA 1993) with the USEPA and the SCDHEC to coordinate remedial activities at SRS into one comprehensive program which 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.

A chronology of site events including the effective dates for the Consent Decree, the FFA, and the NPL Listing is provided in Appendix A. Table 1 provides a chronology of the decision documents for the seven SRS OUs with groundwater remedies evaluated in this report. Chronologies of significant activities and regulatory milestones for individual OUs are included in the site specific remedy review reports (Appendix C through Appendix I).

## III. BACKGROUND

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 by-products 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 SCDHEC operating or post-closure permits under RCRA. SRS received a RCRA hazardous waste permit from the SCDHEC, which was most recently renewed on February 11, 2014. 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).

### Physical Characteristics

SRS occupies approximately 802.9 $km^2$ (310 $mi^2$) of land adjacent to the Savannah River, principally in Aiken and Barnwell counties of South Carolina (Figure 1). SRS is located approximately 40 km (25 mi) southeast of Augusta, Georgia, and 32 km (20 mi) south of Aiken, South Carolina. Approximately 90 percent of SRS land consists of natural and managed forests. The locations at SRS where nuclear materials were produced, stored, and disposed are clustered into distinct industrial areas that are separated by large areas of forest. OUs are generally contained within or adjacent to these industrial areas.

SRS is located on the Atlantic Coastal Plain. Subsurface and groundwater contamination associated with OUs is located in unconsolidated sands and clays. The depth to the water table at SRS varies from just below the surface in wetlands and near streams to approximately 39 m (130 ft) below ground surface. Recharge to the aquifers underlying the SRS is primarily through rainfall. Groundwater flows toward and discharges into site streams and the floodplain of the Savannah River.

### Land and Resource Use

For nearly 40 years, USDOE and its predecessor agencies produced nuclear materials for the nation’s defense programs at SRS. Today, the focus of the USDOE has shifted to environmental stewardship, clean energy initiatives, and national security.

The future land use for all of the OUs at SRS is anticipated to be industrial with the USDOE maintaining control of the land. According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of SRS land should be prohibited.

SRS manages its own drinking and process water supply from groundwater located beneath the SRS. SRS domestic and process water systems are supplied from a network of approximately 40 wells in widely scattered locations across the site, of which 8 wells supply the primary drinking water system. Virtually all site process and drinking water is pumped from the deeper Crouch Branch and McQueen Branch aquifers. The SRS domestic water systems meet state and federal drinking water standards. There is no current or projected future use of surface water or shallow aquifer groundwater as a drinking water source at the SRS.

**History of Contamination**

During the early 1950s, SRS began to produce materials used in nuclear weapons, primarily tritium, plutonium-239, and other special nuclear materials for national defense and the space program. Chemical and radioactive wastes are by-products of nuclear material production processes. These wastes have been treated, stored, and in some cases disposed of at SRS. Hazardous substances, as defined by the CERCLA, are currently present in the environment at SRS, with past disposal practices resulting in soil and groundwater contamination.

**Initial Response**

After SRS was placed on the NPL in 1989, the SRS Site Evaluation program was initiated to identify potential release sites present at SRS that would require investigation and potential remediation under CERCLA. Five hundred fifteen (515) potential release sites have been identified. The FFA includes a schedule for the investigation and remedial action (if needed) for each potential release site.

A core team process for sharing and interpreting information and working together to reach agreement on key remedial decisions among USDOE, USEPA, and SCDHEC was implemented at SRS in 2000. The core team process has made environmental cleanup at SRS efficient and has allowed remediation at many OUs to be accomplished on an accelerated schedule.

The collaborative efforts of the USDOE, USEPA, and SCDHEC support a consistent approach to site characterization, human health and ecological risk analyses, remedy selection, establishment of remedial goals and remedy implementation for individual OUs at SRS. Technical and administrative protocols have been established to promote the consistent implementation of USEPA guidance at OUs across SRS. An environmental database is used to track sampling, analysis, and results of environmental characterization and monitoring. An SRS Area Completion Strategy (WSRC 2006) was developed which allowed for the simultaneous characterization and cleanup of multiple OUs and potential sources of contamination in congested industrial areas.

During the period from April 2009 – September 2012, funds for accelerated environmental cleanup became available as part of the national economic stimulus package authorized by the American Reinvestment and Recovery Act (ARRA). To take advantage of this additional funding, environmental cleanup under CERCLA was expedited by performing removal actions at a number of OUs using the administrative vehicle of Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis reports. Early action remedial decisions were also implemented under ARRA.

Table 1 provides a summary of the remedial actions implemented to date for the seven OUs with groundwater remedies evaluated in this report. Remedial actions include removal actions and remedial actions conducted prior to an interim or final Record of Decision (ROD).

### Basis for Taking Action

Groundwater contaminant plumes associated with SRS OUs cover approximately 2,023 hectares (5,000 acres) of the SRS. The lateral extent of these plumes is indicated on Figure 2. The primary contaminants in groundwater are volatile organic compounds (VOCs) and tritium. Strontium-90, iodine-129, and metals are present in groundwater above drinking water standards to a lesser extent. VOCs are present in the vadose zone between the source unit and the groundwater and act as a secondary source of contamination to the groundwater at a number of OUs.

Based on the remedial investigations and technical evaluations, the OUs addressed in this remedy review were determined to contain hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. The specific contaminants and remedial actions for each OU are described in greater detail in the OU-specific appendices (Appendix C through Appendix I).

## IV. REMEDIAL ACTIONS

Remedial actions may target source areas, soil, vadose zone, and/or groundwater. Remedial goals are defined for individual OUs, but in general, remedial action objectives (RAOs) at SRS are:

- Prevent exposure of trespassers, industrial workers, and hypothetical residents to soils or groundwater containing unacceptable levels of contaminants.
- Prevent exposure of ecological receptors to soils or groundwater containing unacceptable levels of contaminants.
- Prevent or minimize the migration of contaminants to groundwater at levels that exceed maximum contaminant levels (MCLs).
- Prevent or minimize the discharge of contaminated groundwater to surface water at levels that exceed MCLs.

As previously discussed, the Fifth Five-Year Remedy Review Report will be conducted in five phases based on the remedy type. A general description of the five remedy types is provided in Appendix A.

### Systems Operation and Maintenance

A site-wide maintenance program is in place to care for cover systems, signs, monitoring wells, and other infrastructure associated with environmental remediation. Groundwater monitoring networks require maintenance. Identifying signs must be legible and locks and wells covers must be operational. Access to the wells must be maintained. Pumps and fittings periodically require repair or replacement, and sometimes wells are refurbished, redeveloped, or abandoned.

Groundwater monitoring is an important component of operation and maintenance (O&M) at SRS. Groundwater monitoring includes installing monitoring wells, collecting water samples, analysis of samples at laboratories, data management, data interpretation, and document production. Groundwater monitoring reports are produced and submitted to USEPA and SCDHEC for individual OUs where monitoring and reporting are required. Enhancements to the groundwater sampling systems are part of a continual groundwater monitoring well O&M improvement program. For example, Purge Water Management System (PWMS) units were installed at wells that require containerization to decrease the amount of purge water requiring treatment, thus lowering O&M (sampling) costs. As reported in Table 2, Operation and Maintenance Cost Comparison for SRS OUs with Groundwater Remedies, any cost savings from the PWMS units are captured in the actual costs.

The costs of the O&M activities for the seven individual OUs have been compiled as part of this five-year remedy review. As part of the process of selecting the most appropriate action for each OU, the cost of implementing each of the remedies was estimated and reported in the respective remedy decision documents. Table 2 compares the actual costs incurred at SRS OUs with groundwater remedies over the time period from fiscal year (FY) 2012 to FY2015 to the estimated costs from the remedy decision documents projected for the same time period. The review for the actual costs incurred (i.e., FY2012 to FY2015) is based on the time-period since the last review for the seven OUs was conducted in the Fourth Five-Year Remedy Review Report (SRNS 2014). Site-specific details concerning costs incurred are included for each OU in Appendix C through Appendix I.

## V. PROGRESS SINCE LAST REVIEW

For the seven OUs evaluated in this review, the previous protectiveness statements from the Fourth Five-Year Remedy Review Report (SRNS 2014) concluded that all seven OUs were found to be protective.

Recommendations from the Fourth Five-Year Remedy Review Report that impact the seven OUs with groundwater remedies evaluated in this report are as follows:

- Five-year remedy reviews will be conducted in phases with OUs grouped by remedy types. This report presents the second phased review for seven OUs that selected groundwater remediation as the final remedy.
- SRS recommended optimization of groundwater monitoring and reporting at some OUs, consistent with the results of the SRS Groundwater Monitoring Optimization Report (SRNS 2012). For this report, this recommendation pertains to the L-Area Southern Groundwater OU and R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin OU.
- SRS recommended monitoring of 1,4-dioxane for some OUs and reporting of the results in the OU-specific groundwater reports. Based on the monitoring results, the USEPA, SCDHEC, and USDOE will determine whether or not 1,4-dioxane should be permanently added to the list of monitored constituents. For this report, this recommendation pertains to the D-Area Oil Seepage Basin (631-G) (DOSB) OU and R-Area Operable Unit (RAOU). Monitoring of 1,4-dioxane for the Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G OU was implemented in 2013.

## VI. FIVE-YEAR REMEDY REVIEW PROCESS

USDOE has implemented the Fifth Five-Year Remedy Review for SRS OUs with groundwater remedies. The review specifically evaluated remedies by comparing them to the OU-specific decision documents. The following actions were taken to perform the Fifth Five-Year Remedy Review for this category:

- Conducted a scoping meeting on August 18, 2015 with USDOE, USEPA, and SCDHEC to discuss the scope of the report and to establish the review and approval schedule for the report;
- Publication of an announcement on September 9, 2015 that the USDOE is conducting the Fifth Five-Year Remedy Review in phases;
- Reviewed appropriate data, documentation (i.e., including RODs, Early Action RODs, Interim RODs [IRODs], Explanation of Significant Differences), and Land Use Control Implementation Plan required field inspection checklists, etc. The specific data and document references used to review each remedy decision are listed in the OU-specific reports located in Appendix C through Appendix I;
- Confirmed protectiveness of the remedial actions through inspections and interviews. Cognizant personnel were interviewed as to the status and success of the current remedial systems. The results of the inspections and interviews are documented in the Site Inspection Checklist included with the OU-specific reports located in Appendix C through Appendix I;
- Reviewed changes in standards and to-be-considered guidance that would call into question whether the prescribed remedy was meeting the newer standards or guidance. Any problems or discrepancies are reported in the Section VII (Technical Assessment), and Section VIII (Issues), and Section IX (Recommendations and Follow-up Actions) of the OU-specific appendices; and
- Submitted an initial Fact Sheet for review with Revision 0 of the Fifth Five-Year Remedy Review Report for SRS OUs with Groundwater Remedies.

USEPA and SCDHEC performed site inspections of OUs with groundwater remedies with issued RODs or IRODs on March 1, 2016. The Revision 0 report was submitted on December 22, 2015. USDOE will address any comments received from USEPA and SCDHEC and provide a Revision 1 report for USEPA and SCDHEC approval. After the USEPA and SCDHEC approve the report and USDOE, USEPA, and SCDHEC sign this report, a notice of its availability will be published in newspapers in Aiken, Columbia, Barnwell, and Allendale, South Carolina, and in Augusta, Georgia. Additionally, the availability of the report will be announced in *The Savannah River Site Environmental Bulletin*, which will be sent to the SRS mailing list. The report will be made available to the public at four information repositories. A briefing to the Citizens Advisory Board will be conducted prior to finalizing the report.

## VII. TECHNICAL ASSESSMENT

The technical assessment of the environmental cleanup program at SRS in general and each of the OU-specific remedies evaluated in this report (Appendices C through I) is described by answers to the following three questions posed by the USEPA.

- Question A: Is the remedy functioning as intended by the decision documents?
- Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs still valid?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

**Question A: Is the remedy functioning as intended by the decision documents?**

SRS groundwater remedies and related activities are functioning as intended as demonstrated below.

- Passive and Low Energy soil vapor extraction (SVE) Systems, solar powered MicroBlowers™ and barometric pressure operated BaroBalls™ continue to remove contaminants from subsurface soils contaminated by low concentrations of VOCs.
- Thermal technologies (ERH) have been successful in removing very high concentrations of VOCs from subsurface zones. Groundwater data at Monitored Natural Attenuation (MNA) remedy plumes indicates that groundwater concentrations are generally decreasing and plumes are not expanding.

- Contaminated material has been excavated and consolidated or left in place under protective cover systems breaking the pathway for worker exposure and for the migration of contaminants to groundwater.

**Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs still valid?**

Answer: The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid for all of the OUs included in this report. An evaluation of changes in chemical and radiological standards that were in place when the last five-year remedy review was initiated in 2012 to the standards applicable in 2015 was conducted to determine if there were any changes that would affect the protectiveness of the selected remedies. There were no changes in chemical and radiological specific standards that would affect the protectiveness of the remedies. There were no changes in action-specific or location-specific requirements that would impact any remedy. This evaluation is included in Appendix B and described in the OU-specific appendices.

**Question C: Has any other information come to light that could call into question the protectiveness of the remedy?**

Answer: No other information that could call into question the protectiveness of the selected remedies and no outstanding issues have been identified in this Fifth Five-Year Remedy Review with the exception of the CMP Pits OU. There are increasing volatile organic compound trends in the Lower Aquifer Zone (LAZ) that were predicted by the 2002 groundwater modeling for the CMP Pits OU. The contamination remains in the upper half of the LAZ; wells with high concentrations are located at the top of the LAZ. An upcoming modeling effort will address any further plume expansion, discharge concentrations, and timeframe of remediation compared to active remediation options. The CMP Pits OU remedy is currently protective; however, in order to establish long-term protectiveness, additional remedial actions may need to be evaluated and selected, as necessary, based on results of groundwater modeling and continued groundwater and surface water monitoring.

For all OUs, land use at SRS remains consistent with assumptions in the respective decision documents.

### Technical Evaluation Summary

According to the data reviewed, the site inspections, and interviews, the remedies selected for the SRS OUs included in this report are functioning as intended by the decision documents. The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid for all of the OUs included in this report. No new information has come to light that calls into question the protectiveness of the remedies.

## VIII. ISSUES

Remedial actions evaluated in this Five-Year Remedy Review for SRS remain protective of human health and the environment and are functioning as intended. Although the remedial actions for the DOSB OU and the RAOU continue to be protective, 1,4-dioxane was identified as a potential contaminant at the two OUs based on its association with other solvents present. Currently, there is a lack of groundwater data to dismiss 1,4-dioxane as being present at levels which would be harmful to human health and the environment.

## IX. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

SRS recommends monitoring of 1,4-dioxane at the DOSB OU and the RAOU followed by reporting the results in the appropriate OU-specific groundwater monitoring reports. Based on the monitoring results, the USEPA, SCDHEC, and USDOE will determine whether or not 1,4-dioxane should be permanently added to the list of monitored constituents for the two OUs.

## X. PROTECTIVENESS STATEMENT(S)

The protectiveness statements for each remedy are based on the recommended language from the *Comprehensive Five-Year Review Guidance* (USEPA 2001) and the supplemental guidance, *Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews* (USEPA 2012).

For the seven OUs evaluated in this Five Year Remedy Review, the groundwater remedies have been determined to be protective of human health and the environment. However, the remedy for the CMP Pits OU has been determined to be protective in the short-term. In order to establish long-term protectiveness, additional remedial actions may need to be evaluated and selected, as necessary, based on results of groundwater modeling and continued groundwater and surface water monitoring. LUCs are part of final remedial actions where hazardous substances, pollutants, or contaminants remain on-site above levels that allow for unlimited use and unrestricted exposure. For the OUs evaluated in this report, pathways for contaminants to reach human and ecological receptors have been successfully broken by the selected remedies including LUCs with the exception of the C-Area Groundwater (CAGW) OU. Because the remedy for the CAGW OU is an interim remedy, LUCs will be addressed (if needed) as a component of the remedy in the final ROD.

A protectiveness statement for the seven OUs evaluated in this report is included in the OU-specific remedy review located in Appendix C through Appendix I. The protectiveness statements are also provided in the Five-Year Review Summary Form located in the Executive Summary.

## XI. NEXT REVIEW

As established in Section 121 of CERCLA, as amended by the SARA and the NCP, periodic reviews are required at least every five years for sites where hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure following the completion of all remedial actions.

Barring a change in the governing laws, another review should be completed within five years from the signature date of this document. The Fifth Five-Year Remedy Review will be conducted in five phases. The final signature date for the last grouping of the Fifth Five-Year Remedy Review Report is due no later than January 21, 2019.

## XII. OU-SPECIFIC FIVE-YEAR REMEDY REVIEW REPORTS

The OU-specific Five-Year Remedy Reviews for the seven remedies evaluated in this document are included in Appendix C through Appendix I.

## XIII. REFERENCES

FFA, 1993. *Federal Facility Agreement for the Savannah River Site*, Administrative Docket Number 89-05-FF, WSRC-OS-94-52, Effective Date: August 16, 1993

SRNS, 2012. *EC&ACP Groundwater Monitoring Optimization Report: A Comprehensive, Technical Approach for the Evaluation and Optimization of Groundwater Monitoring and Reporting (U)*, SRNS-RP-2012-0196, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *Fourth Five-Year Remedy Review Report for the Savannah River Site (U) Aiken, South Carolina*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015. *Fifth Five-Year Remedy Review Report for the Savannah River Site Operable Units with Native Soil Covers and/or Land Use Controls (U) Aiken, South Carolina*, SRNS-RP-2014-00902, Revision 1, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

USEPA, 2001. *Comprehensive Five-Year Review Guidance*, EPA 540-R-01-007, OSWER No. 9355.7-03B-P, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response

USEPA, 2011. *Recommended Evaluation of Institutional Controls: Supplement to the "Comprehensive Five-Year Review Guidance"*, OSWER Directive 9355.7-18, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

USEPA, 2012. *Clarifying the Use of Protectiveness Determinations for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews*, OSWER Directive 9200.2-111, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

WSRC, 1997. *Five-Year Review of Records of Decision Report (U)*, WSRC-RP-97-403, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2003. *Second Five-Year Review Report for the Savannah River Site (U)*, WSRC-RP-2001-4163, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006. *Area Completion Strategy for the Savannah River Site (U)*, ERD-EN-2005-0084, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Third Five-Year Remedy Review Report for the Savannah River Site (U)*, WSRC-RP-2007-4063, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC

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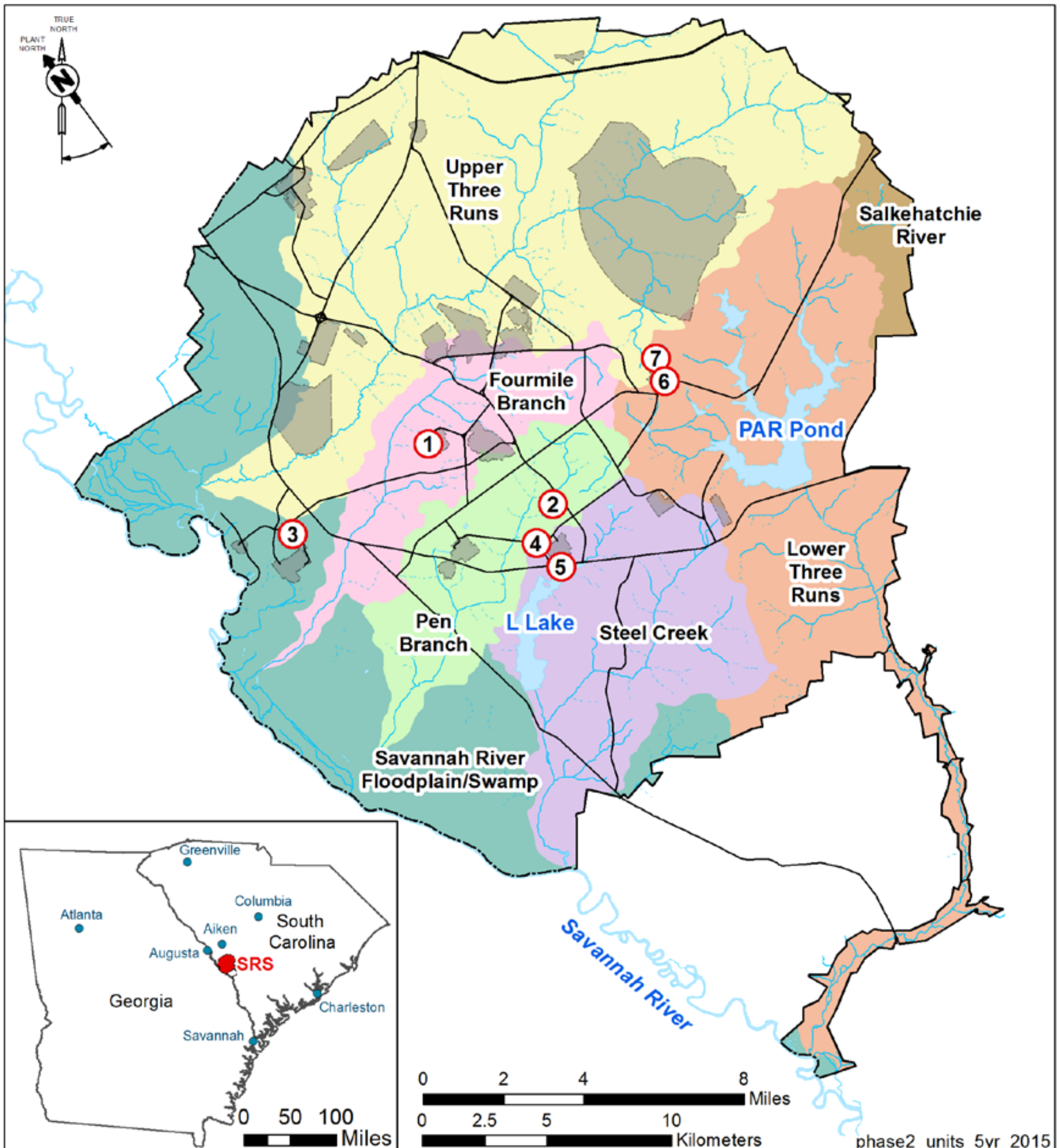


1. C-Area Groundwater Operable Unit
2. Chemicals, Metals, and Pesticides Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit
3. D-Area Oil Seepage Basin (631-G) Operable Unit
4. L-Area Burning/Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) Operable Unit
5. L-Area Southern Groundwater Operable Unit
6. R-Area Operable Unit
7. R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit

**Figure 1. Location Map for SRS OUs with Groundwater Remedies**

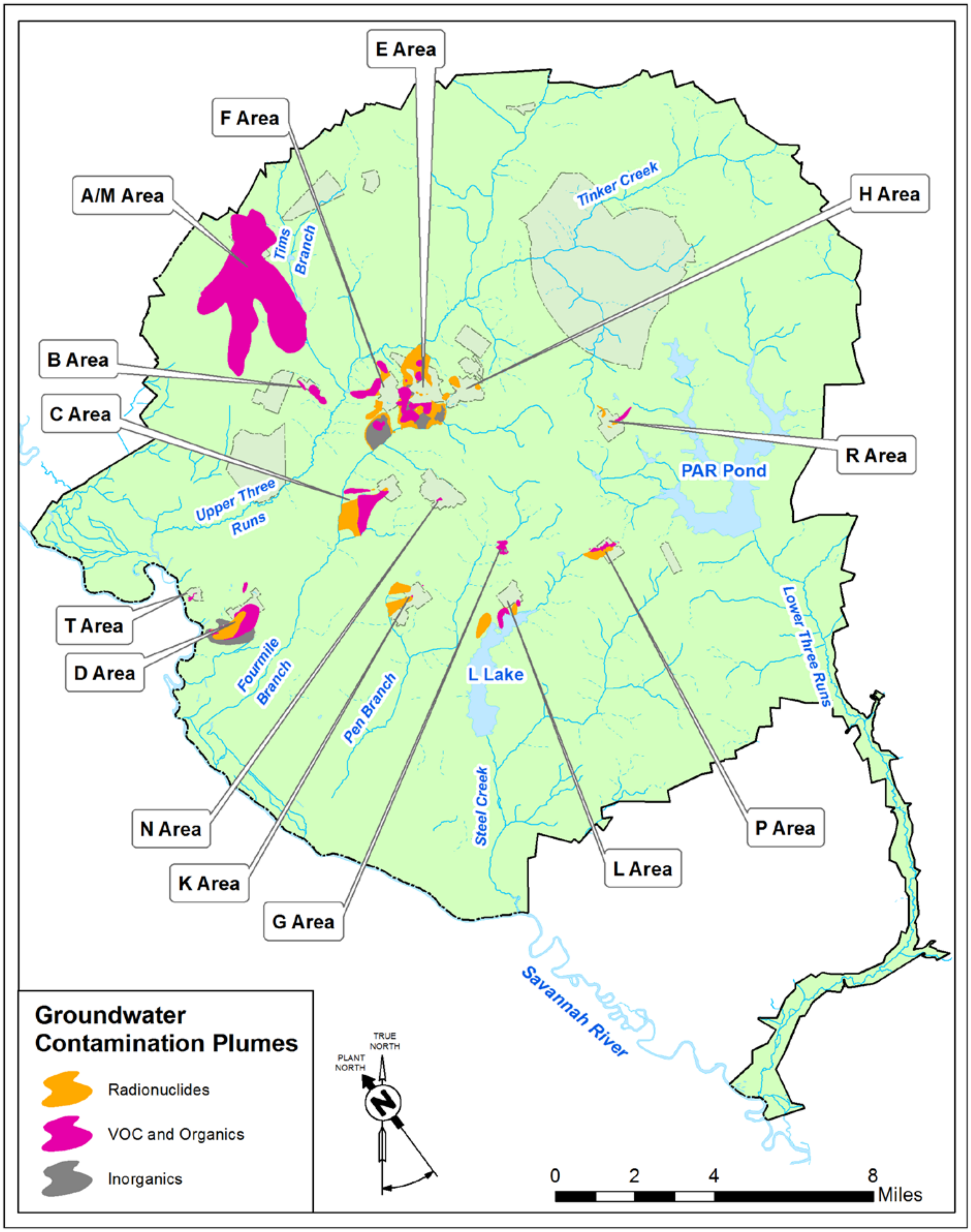


**Figure 2. Groundwater Contamination at the Savannah River Site**

**Table 1. SRS OUs with Groundwater Remedies**

| # | Appendix | Operable Unit | CERCLIS No. | Remedy Decision Document | Decision Document Issuance Year | Remedial Action[a] |
|---|---|---|---|---|---|---|
| 1 | C | C-Area Groundwater | 82 | IROD | 2004 | Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE)[b] |
| 2 | D | Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G) | 24 | ROD | 2005 | Enhanced Bioremediation, ERH, SVE, Passive SVE, Soil Cover, Monitored Natural Attenuation (MNA), and Land Use Controls (LUCs) |
| 3 | E | D-Area Oil Seepage Basin (631-G) | 27 | ROD | 1999 | Removal Action (Excavation), Groundwater Mixing Zone (GWMZ), LUCs |
| 4 | F | L-Area Burning/Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) | 56 | ROD | 2003 | Removal Action (Excavation), GWMZ, LUCs |
| 5 | G | L-Area Southern Groundwater | 77 | ROD<br>ESD | 2007<br>2014 | MNA, LUCs |
| 6 | H | R-Area Operable Unit | 95 | ROD | 2011 | Removal Actions (ISD of R-Reactor Building [105-R], Excavation, Cover), MNA, LUCs |
| 7 | I | R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin | 25 | ROD | 2004 | Concrete Intruder Barrier, Excavation, On-Site Disposal, GWMZ, LUCs |

a The seven OUs were grouped together because of similar groundwater remedies and monitoring activities. Some OUs may also include subunits with contaminants in soils or building material (i.e., concrete) that are addressed by the remedy decision document.

b LUCs are not a component of the interim remedy and will be addressed (if needed) by the final remedial action for the C-Area Groundwater OU.

## Table 2. Operation and Maintenance Cost Comparison for SRS OUs with Groundwater Remedies

| Operable Unit | Main Remedy | Remedy Decision Document Year[a] | FY2012-FY2015 O&M Estimated Cost | FY2012-FY2015 O&M Actual Cost | % of Estimate | Comments |
|---|---|---|---|---|---|---|
| C-Area Groundwater | Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE)[a], | 2004 | $174,000 | $36,133 | 21 | Actual costs are significantly less than expected because the required length of monitoring the ERH with SVE was shortened from 6 years to 1 year. |
| Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G) | Enhanced Bioremediation, ERH, SVE, Passive SVE, Soil Cover, Monitored Natural Attenuation (MNA), LUCs | 2005 | $160,896 | $725,214 | 451 | Actual costs were higher than expected because groundwater monitoring and reporting costs were higher than expected and additional work was conducted based on regulatory input. |
| D-Area Oil Seepage Basin (631-G) | Removal Action (Excavation), Groundwater Mixing Zone (GWMZ), LUCs | 1999 | $67,886 | $216,204 | 319 | Actual costs are higher than expected because groundwater monitoring and reporting costs are higher. |
| L-Area Burning/Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) | Removal Action (Excavation), GWMZ, LUCs | 2003 | $27,000 | $56,569 | 210 | Actual costs are higher than expected because groundwater monitoring and reporting costs are higher. |
| L-Area Southern Groundwater | MNA, LUCs | 2007 | $227,560 | $216,272 | 95 | |
| R-Area Operable Unit | Removal Actions (ISD of R-Reactor Building [105-R], Excavation, Cover), MNA, LUCs | 2011 | $204,200 | $975,432 | 403 | Actual costs are higher than expected because groundwater monitoring reports are being submitted annually. Additional maintenance activities were also required. |
| R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin | Concrete Intruder Barrier, Excavation, On-Site Disposal, GWMZ, LUCs | 2004 | $1,293,326 | $616,165 | 48 | Actual costs are less than expected due to optimization of the groundwater monitoring. |

a LUCs are not a component of the interim remedy and will be addressed (if needed) by the final remedial action for the C-Area Groundwater OU.

# FIFTH FIVE-YEAR REMEDY REVIEW REPORT PHASED REVIEWS

## I. FIVE-YEAR REMEDY REVIEW PHASES

The size of the Savannah River Site (SRS) five-year remedy review reports has grown considerably since the first report was issued in 1997 with respect to the number of operable unit (OU) remedies evaluated and the level of detail required. For the Fifth Five-Year Remedy Review Report, the U.S. Department of Energy, U.S. Environmental Protection Agency (USEPA), and South Carolina Department of Health and Environmental Control (SCDHEC) agreed to segregate the OUs into five groupings based on remedy similarity with a different group submitted annually on a five-year cycle. This phased approach not only reduces the volume of future remedy reports, but is also more effective in identifying and resolving issues for similar remedies.

The SRS OUs are grouped by the following remedy types:

(1) Native Soil Covers and/or Land Use Controls (LUCs);
(2) Groundwater Remedies;
(3) Engineered Cover Systems;
(4) Geosynthetic or Stabilization/Solidification Cover Systems; and
(5) Operating Equipment.

The trigger date for submittal of the next five-year remedy review report to the regulatory agencies is based on the USEPA signature date of the previous report. The final signature for the last grouping of Fifth Five-Year Remedy Review Report is due no later than January 21, 2019. Prior to implementing the five annual remedy review submittals, a transitional period is necessary to prevent exceeding the five year limit required between decision document reviews in order to remain in compliance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan. Issuance dates for the Fifth Five-Year Remedy Review Report during the transitional period are scheduled to occur over a four-year period (2016 - 2019). Table A-1 provides an overview of the number of years between remedy reviews for the five OU remedy groupings beginning with the transitional period between the fourth, fifth, and sixth reports until the five-year cycle is fully established between the sixth and seventh year reports.

A list of the SRS OUs with remedy decision documents grouped into one of the five phased reviews is provided in Table A-2. Table A-2 will be updated in future remedy review reports as additional remedy decision documents are approved. A general description of the five remedy types is provided below.

***Phase 1: Native Soil Covers and/or LUCs***

For purposes of the fifth five-year phased remedy review, SRS OUs with native soil covers and/or LUCs as the selected remedy are grouped under the Native Soil Covers and/or LUCs category.

Native soil covers are often implemented at SRS to protect against human and/or ecosystem exposure to waste or contaminated material left in place. Native soil covers are appropriate when water infiltration and leaching of contaminants to groundwater is not a concern. A typical soil cover is 0.30 m to 0.61 m (12 to 24 inches) thick and is usually vegetated to minimize erosion. Native soil covers are usually low in cost and construction and materials are readily available from SRS local sources. Native soil covers may be combined with other remedial actions, but require LUCs as a component of the remedy. For these units, native soil covers were in place prior to selection of the remedial action. For this reason, only LUCs were required as the final remedial action for the nine OUs with existing soil covers discussed in the Native Soil Covers and/or LUCs report.

LUCs are maintained for all OUs where hazardous substances, pollutants, or contaminants remain on-site or have been left in place above levels that are acceptable for unlimited use and unrestricted exposure. LUCs may be implemented as a stand-alone remedy or combined with other remedial actions. LUCs involve institutional controls (i.e., administrative controls) and engineering controls and can include monitoring, maintenance, reporting, access restrictions, signage, fencing, and land use restrictions. In older SRS remedy documents, the term “institutional controls” was often used in place of the broader LUC term.

***Phase 2: Groundwater Remedies***

For purposes of the fifth five-year phased remedy review, SRS OUs that have similar groundwater monitoring activities, primarily associated with Monitored Natural Attenuation (MNA) or a Mixing Zone (MZ) permit, are grouped in the Groundwater category.

SRS uses a graded approach to groundwater remediation. The selection of groundwater remediation technologies for a specific contamination area is based on the size, contaminant type, contaminant concentration, and configuration of the plume. These attributes are the result of the nature and mass of the source of contamination and the subsurface characteristics in the area of the plume. Many large plumes consist of several zones that are most efficiently addressed with separate complementary corrective action/remedial technologies. The highest concentrations of contaminants are found in the source zone. The most robust, high-mass-removal technologies are best suited for remediation of the source zone. In the primary plume zone, active remedies such as pump-and-treat may be necessary to remove contaminants and exert hydraulic control of the plume. In the dilute fringe zone, contaminants are generally low in concentration and can often be treated with passive techniques.

Enhanced-passive remedial systems are used extensively at SRS for groundwater remediation. These are low-energy-consumption, low-carbon-emission systems that are not completely passive. These “green” technologies leverage natural systems to protect and remediate groundwater. Many existing soil vapor extraction (SVE) systems have been converted from active vacuum extraction powered by fossil fuel to enhanced-passive systems powered by natural non-fossil-fuel energy sources. BaroBall™ and MicroBlower™ systems are two types of enhanced-passive SVE systems currently in operation at SRS. BaroBalls™ rely on natural fluctuations in barometric pressure to pump volatile organic compounds (VOCs) from the subsurface to the atmosphere at individual SVE wells. SVE wells with MicroBlowers$^{TM}$ are designed to use solar power to generate a vacuum that exhausts VOC vapors from individual wells. Both MicroBlowers$^{TM}$ and BaroBalls$^{TM}$ are low-energy-consumption, low-carbon-emission devices that remove VOC contaminants from the subsurface.

MNA is a passive groundwater remedial action where the fringe and dilute areas of a plume degrade by natural biogeochemical or physical processes such as biodegradation, radioactive decay, dilution, and simple dispersion. MNA remedies must be accompanied by source control and a technical justification that conditions are favorable for natural attenuation. In addition, the groundwater plume should not be expanding significantly, and surface water standards cannot be exceeded at the groundwater discharge point. MNA remedy justifications are supported by groundwater modeling and a commitment to continued monitoring and reporting. When only the uppermost aquifer is impacted, SCDHEC may issue a MZ permit that is essentially a permit for an MNA remedy. SRS has a mixture of CERCLA Record of Decisions (RODs) that require MNA as the final action for groundwater under CERCLA, and RODs that require SCDHEC MZ permits to implement the MNA remedy.

***Phase 3: Engineered Cover Systems***

For purposes of the fifth five-year phased remedy review, SRS OUs that selected an engineered cover system or similar cover system as the remedy are grouped in the Engineered Cover Systems category.

The function of an engineered cover system is similar to native soil covers to protect against human and/or ecosystem exposure to waste or contaminated material left in place. Although engineered covers do not prevent infiltration, they can achieve very low permeabilities if well compacted. Compaction is important to reduce damage from differential settlement and is often used at SRS to remediate OUs that contain diverse waste material such as rubble pits/piles. Another objective of using engineered cover systems is to promote more effective surface drainage and to minimize runoff.

SRS OUs were placed in this grouping if the selected cover features exceeded those of a basic native soil cover. For example, an OU with a remedy that selected cover and/or fill material with a higher clay content in order to minimize infiltration or for drainage and slope contouring was included in this category even if the clay material did not have engineering compaction requirements.

***Phase 4: Geosynthetic or Stabilization/Solidification Cover Systems***

For purposes of the fifth five-year phased remedy review, SRS OUs that installed a geosynthetic or stabilization/solidification cover system are grouped in the Geosynthetic or Stabilization/Solidification Cover Systems category.

Many cover systems are designed to protect groundwater by minimizing the infiltration of rainwater through the contaminated material left in place. Geosynthetic cover systems are constructed at SRS OUs when there is a concern that contamination left in place may leach to groundwater above acceptable levels. A typical cross section of a geosynthetic cover system consists of a vegetative/soil protective layer, a geosynthetic drainage layer, an impermeable geosynthetic liner, and compacted common fill placed over the contaminated material. A specific hydraulic conductivity to reduce storm water infiltration, usually $1 \times 10^{-7}$ cm/s or less, is specified in the design. Low permeability covers are often paired with SVE units that remove VOCs from the subsurface soil beneath the OU to prevent migration of contaminants to groundwater.

In some cases, radioactively contaminated soils have been stabilized with in-situ grouting followed by installation of a low permeability cover (i.e., compacted clay, concrete, etc.) to deter migration of contaminants to the groundwater. Not only does a stabilization/solidification technology stabilize waste left in place, the in-situ containment also provides another layer of protection to prevent intrusion and exposure to contaminated material.

***Phase 5: Operating Equipment***

For purposes of the fifth five-year phased remedy review, SRS OUs that have ongoing active remediation systems are grouped under the Operating Equipment category.

A range of active remediation systems are used at SRS. SVE systems are used to remove VOCs from vadose zone source areas before the contaminants can migrate to the water table. Air strippers are employed to remove VOC contaminants from the source zone while active recirculation well systems remove VOC contaminants from primary VOC plume. Pump and treat systems are used to remove contaminant mass and exert hydraulic control over contaminated groundwater plumes. Thermal technologies have been employed in several areas to mobilize dense non-aqueous phase liquid (DNAPL) VOCs in the vadose zone and groundwater. Dynamic Underground Stripping is a technology employed at SRS that utilizes steam injection to enhance removal from large DNAPL source zones. Electrical Resistance Heating has been used in smaller DNAPL source zones.

A more detailed discussion of active remediation systems will be provided during Phase 5 of the fifth five-year phased remedy review.

## II. SRS OUS WITH REMEDIAL DECISIONS

The following tables are included for information only and provide a tracking for all SRS OUs with approved remedial decisions, including No Action sites [i.e., RODs, Early Actions RODs (EARODs), Interim RODs (IRODs), ROD Amendments, and Explanation of Significant Differences (ESDs)].

- Table A-3 chronologically lists all SRS issued decision documents. Document numbers are provided for reference;
- Table A-4 provides a summary of the no remedial actions selected in the decision documents; and
- Table A-5 provides the OU subunits with issued remedial decision documents and their associated Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) number.

**Table A-1. Phased Five-Year Remedy Review Report Schedule**

| Fourth Five-Year Review | | Fifth Five-Year Review | | Sixth Five-Year Review | | Seventh Five-Year Review | |
|---|---|---|---|---|---|---|---|
| Issuance Year | Years Between Reviews | Issuance Year | Years Between Reviews | Issuance Year | Years Between Reviews | Issuance Year | Remedy Type |
| 2014 | 2 | 2016 [a] | 4 | 2020 | 5 | 2025 | Phase 1: Native Soil Covers and/or LUCs |
| 2014 | 3 | 2017 [b] | 4 | 2021 | 5 | 2026 | Phase 2: Groundwater Remedies |
| 2014 | 4 | 2018 | 4 | 2022 | 5 | 2027 | Phase 3: Engineered Cover Systems |
| 2014 | 4 | 2018 | 5 | 2023 | 5 | 2028 | Phase 4: Geosynthetic or Stabilization/ Solidification Cover Systems |
| 2014 | 5 | 2019 | 5 | 2024 | 5 | 2029 | Phase 5: Operating Equipment |

a The Fifth Five-Year Remedy Review Report for SRS OUs with Native Soil Covers and LUCs was issued ahead of schedule in November 2015.
b Indicates the issue year for this report: Fifth Five-Year Remedy Review Report for SRS OUs with Groundwater Remedies

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**Table A-2. Fifth Five-Year Remedy Review Report Phases for SRS OUs**

| Native Soil Covers and/or LUCs | | Groundwater | | Engineered Cover Systems | | Geosynthetic or Stabilization/Solidification Cover Systems | | Operating Equipment | |
|---|---|---|---|---|---|---|---|---|---|
| ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** |
| **2014** | **2015** | **2015** | **2017** | **2016** | **2018** | **2016** | **2018** | **2017** | **2019** |
| C-, K-, and L-Reactor Complexes | | C-Area Groundwater | | Central Shops Burning/Rubble Pits (631-1G and 631-3G) | | B-Area Operable Unit | | A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A), Miscellaneous Chemical Basin (731-4A) and Metals Burning Pit (731-5A) | |
| Early Construction and Operational Disposal Site (ECODs) L-1, N-2, P-2, and R-1A, -1B, -1C | | Chemicals, Metals, and Pesticides Pit (080-170G, -171G, -180G, -181G, -182G, -183G, -190G) | | D-Area Burning/Rubble Pits (431-D, -1D) | | C-Area Reactor Seepage Basins (904-66G, 904-68G) | | A/M Area Groundwater | |
| F-Area Burning/Rubble Pits (231-F, 231-1F, 231-2F) | | D-Area Oil Seepage Basin (631-G) | | F-Area Hazardous Waste Management Facility (904-41G, -42G, -43G) | | D-Area Expanded Operable Unit Consisting of D-Area Ash Basin (488-D) and D-Area Rubble Pit (431-2D) | | A-Area Miscellaneous Rubble Pile (731-6A) | |
| Gunsite 012 | | L-Area Burning/Rubble Pit (131-L) | | Ford Building Seepage Basin (904-91G) | | E-Area Low-Level Waste Facility (643-26E) | | C-Area Burning/Rubble Pits (131-C) | |
| Heavy Equipment Wash Basin (NBN) | | L-Area Southern Groundwater | | H-Area Hazardous Waste Management Facility (904-44G, -45G, -46G, -56G) | | F-Area Tank Farm | | D-Area Operable Unit | |
| K-Area Bingham Pump Outage Pit (643-1G) | | R-Area Operable Unit | | K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G) | | F-Area Retention Basin (281-3F) | | F-Area Groundwater Operable Unit (904-41G, -42G, -43G) | |
| L-Area and P-Area Bingham Pump Outage Pits (643-2G, 643-3G, 643-4G) | | R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G) and 108-4R Overflow Basin | | M-Area Hazardous Waste Management Facility (904-51G, 904-112G) | | General Separations Area Consolidation Unit | | H-Area Groundwater Operable Unit (904-44G, -45G, -46G, -56G) | |

**Table A-2. Fifth Five-Year Remedy Review Phases for SRS OUs (*continued/end*)**

| **Native Soil Covers and/or LUCs** | | **Groundwater** | | **Engineered Cover Systems** | | **Geosynthetic or Stabilization/Solidification Cover Systems** | | **Operating Equipment** | |
|---|---|---|---|---|---|---|---|---|---|
| ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** | ***Submittal Date***[a] | ***Issuance Year*** |
| **2014** | **2015** | **2015** | **2017** | **2016** | **2018** | **2016** | **2018** | **2017** | **2019** |
| PAR Pond (685-G) (Including the Pre-Cooler Ponds and Canals) and Lower Three Runs IOU Tail Portion (Middle and Lower Subunits) | | | | Metallurgical Laboratory Hazardous Waste Management Facility (904-110G) | | K-Area Reactor Seepage Basin (904-65G) | | M-Area Inactive Process Sewer Lines (081-M) | |
| R-Area Bingham Pump Outage Pits (643-8G, 643-9G and 643-10G) and R-Area Unknown Pits #1, #2, and #3 | | | | Mixed Waste Management Facility (643-28E) | | L-Area Oil and Chemical Basin (904-83G) | | M-Area Operable Unit | |
| Silverton Road Waste Unit (731-3A) | | | | SRL Seepage Basins (904-53G1, 904-53G2, 904-54G, and 904-55G) | | L-Area Reactor Seepage Basin (904-64G) and C-Area Reactor Seepage Basin (904-67G) | | P-Area Burning/Rubble Pit (131-P) | |
| Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit[b] | | | | | | Old F-Area Seepage Basin (904-49G) | | TNX Area Operable Unit | |
| | | | | | | P-Area Operable Unit | | | |
| | | | | | | P-Area Reactor Seepage Basin (904-61G, 904-62G, 904-63G) | | | |
| | | | | | | R-Area Burning/Rubble Pits (131-R, -1R) and R-Area Rubble Pile (631-25G) | | | |
| | | | | | | T-Area Operable Unit | | | |

a Represents December submittal date of the Revision 0 document for each five-year remedy review report.
b ROD was approved in 2014, but document has not been issued. This OU is not included in the first phase of the fifth five-year review (i.e., native soil covers and/or LUCs) because the remedy has not been implemented.

## Table A-3. Chronological Listing of SRS Issued Decision Documents

| Document Title[a] | Document Number | Rev. | Issuance Date[b] |
|---|---|---|---|
| Consent Decree Signed | | | May 26, 1988 |
| NPL Listing Effective Date | | | December 21, 1989 |
| A/M Area Groundwater Interim ROD (RCRA) | WSRC-RP-92-744 | 0 | September 16, 1992 |
| M-Area Hazardous Waste Management Facility (904-51G, -112G) Interim ROD (RCRA) | WSRC-RP-92-743 | 0 | September 16, 1992 |
| Metallurgical Laboratory Hazardous Waste Management Facility (904-110G) Interim ROD (RCRA) | WSRC-RP-92-745 | 0 | September 16, 1992 |
| Federal Facility Agreement Declared Effective | | | August 16, 1993 |
| F-Area Hazardous Waste Management Facility (904-41G, -42G, -43G) ROD (RCRA) | WSRC-RP-93-1042 | 1 | October 1, 1993 |
| H-Area Hazardous Waste Management Facility (904-44G, -45G, -46G, -56G) ROD (RCRA) | WSRC-RP-93-1043 | 1 | October 1, 1993 |
| Mixed Waste Management Facility (643-28E) ROD (RCRA)[c] | WSRC-RP-93-1511 | 1 | September 23, 1994 |
| Tank 105-C Hazardous Waste Management Facility ROD (RCRA)[c] | WSRC-RP-94-106 | 1 | September 23, 1994 |
| TNX Groundwater Operable Unit Interim ROD[c] | WSRC-TR-94-0375 | 1 | November 16, 1994 |
| PAR Pond (685-G) Interim ROD[c] | WSRC-RP-93-1549 | 0 | February 16, 1995 |
| F-Area Groundwater Operable Unit (904-41G, -42G, -43G) Interim ROD (RCRA)[c] | WSRC-RP-94-1162 | 1 | April 13, 1995 |
| H-Area Groundwater Operable Unit (904-44G, -45G, -45G, -56G) Interim ROD (RCRA)[c] | WSRC-RP-94-1163 | 1 | April 13, 1995 |
| M-Area West Unit (631-21G) ROD[c] | WSRC-RP-95-626 | 0 | September 29, 1995 |
| Old Radioactive Waste Burial Ground (643-E) Interim ROD | WRSC-RP-96-102 | 0 | July 25, 1996 |
| Burma Road Rubble Pit (231-4F) ROD | WSRC-RP-96-101 | 1 | July 25, 1996 |
| D-Area Burning/Rubble Pits (431-D, 431-1D) ROD | WSRC-RP-96-867 | 1 | July 3, 1997 |
| F-Area Burning/Rubble Pits (231-F, 231-1F, and 231-2F) ROD | WSRC-RP-96-868 | 1 | July 3, 1997 |
| Grace Road Site (631-22G) ROD | WSRC-RP-96-160 | 1 | July 3, 1997 |
| Gunsite 113 Access Road Unit (631-24G) ROD | WSRC-RP-96-833 | 1 | July 3, 1997 |
| Gunsite 720 Rubble Pit Unit (631-16G) ROD | WSRC-RP-96-832 | 1 | July 3, 1997 |
| Silverton Road Waste Unit (713-3A) ROD | WSRC-RP-96-171 | 1 | July 3, 1997 |
| Central Shops Burning/Rubble Pit (631-6G) ROD | WSRC-RP-96-873 | 1 | July 3, 1997 |
| Old F-Area Seepage Basin (904-49G) ROD | WRSC-RP-96-872 | 1.1 | July 3, 1997 |

**Table A-3. Chronology of All RODs, IRODs, EARODs, ROD Amendments, and ESDs Issued at SRS *(continued)***

| Document Title[a] | Document Number | Rev. | Issuance Date[b] |
|---|---|---|---|
| ***First Five-Year Remedy Review*** | ***WSRC-RP-97-403*** | ***0*** | ***August 27, 1997*** |
| TNX Groundwater Operable Unit ESD | WSRC-RP-97-169 | 1 | October 10, 1997 |
| K-Area Bingham Pump Outage Pit (643-1G) ROD | WSRC-RP-97-178 | 1 | June 11, 1998 |
| C-, F-, K-, and P-Area Coal Pile Runoff Basins (189-C, 289-F, 189-K, 189-P) ROD[c] | WSRC-RP-97-850 | 1 | November 10, 1998 |
| L-Area Oil and Chemical Basin and L-Area Acid/Caustic Basin (904-83G, -79G) ROD | WSRC-RP-97-143 | 1 | November 10, 1998 |
| 716-A Motor Shops Seepage Basin (904-101G) ROD | WSRC-RP-97-840 | 0 | November 16, 1998 |
| Fire Department Hose Training Facility (904-113G) ROD | WSRC-RP-97-171 | 1 | November 16, 1998 |
| Old F-Area Seepage Basin (904-49G) ESD | WSRC-RP-98-4123 | 1 | December 16, 1998 |
| **D-Area Oil Seepage Basin (631-G) ROD** | **WSRC-RP-97-402** | **1** | **May 7, 1999** |
| C-Area Burning/Rubble Pit (131-C) Interim ROD | WSRC-RP-98-4039 | 0 | May 7, 1999 |
| F-Area Retention Basin (281-3F) ROD | WSRC-RP-97-145 | 1.1 | May 19, 1999 |
| Ford Building Waste Site (643-11G) ROD | WSRC-RP-98-4066 | 1 | October 13, 1999 |
| **Chemicals, Metals, and Pesticides Pits (080-170G, -171G, -180G, -181G, -182G, -183G, -190G) Interim ROD** | **WSRC-RP-98-4192** | **1.1** | **January 19, 2000** |
| SRL Seepage Basins (904-51G1, -52G2, -52G, -55G) ROD | WSRC-RP-97-848 | 1.1 | April 26, 2000 |
| C-Reactor Seepage Basins (904-66G, -67G, -68G) Plug-In ROD ESD | WSRC-RP-2000-4032 | 0 | October 18, 2000 |
| L & P Bingham Pump Outage Pits (643-2G, -3G, -4G) ROD | WSRC-RP-98-4015 | 1 | October 18, 2000 |
| Burma Road Rubble Pit, 231-4F ESD[c] | WSRC-RP-98-4170 | 1 | February 6, 2001 |
| A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A) Interim ROD | WSRC-RP-2000-4001 | 1 | February 9, 2001 |
| Miscellaneous Chemical Basin/Metals Burning Pit (731-4A/5A) Interim ROD | WSRC-RP-98-4031 | 1.1 | February 9, 2001 |
| West of SRL “Georgia Fields” Site (631-19G) ROD | WSRC-RP-99-4164 | 0 | February 22, 2001 |
| F-Area Retention Basin (281-3F) ESD[c] | WSRC-RP-2000-4079 | 1 | June 7, 2001 |
| K-Area Burning/Rubble Pit (131-K & 631-20G) ROD[c] | WSRC-RP-97-862 | 1 | August 8, 2001 |
| ORWBG Old Solvent Tanks (650-01E - 22E) Interim ROD | WSRC-RP-2000-4193 | 1 | September 27, 2001 |
| Ford Building Seepage Basin ROD | WSRC-RP-2000-4156 | 1 | April 5, 2002 |
| **Chemical, Metals, and Pesticides Pits Interim ROD Amendment** | **WSRC-RP-2000-4158** | **1.2** | **April 8, 2002** |

**Table A-3. Chronology of All RODs, IRODs, EARODs, ROD Amendments, and ESDs Issued at SRS *(continued)***

| Document Title[a] | Document Number | Rev. | Issuance Date[b] |
|---|---|---|---|
| K-Area Reactor Seepage Basin ESD[c] | WSRC-RP-99-4200 | 1.1 | September 16, 2002 |
| General Separations Area Consolidation Unit ROD | WSRC-RP-2002-4002 | 0 | October 25, 2002 |
| Central Shops Sludge Lagoon (080-24G) ROD | WSRC-RP-2000-4189 | 1 | November 15, 2002 |
| C-Area & L-Area Reactor Seepage Basin ROD Amendment | WSRC-RP-2002-4063 | 1 | December 5, 2002 |
| R-Area Acid/Caustic Basin (904-77G) ROD | WSRC-RP-2002-4015 | 1 | February 10, 2003 |
| **L-Area Burning/Rubble Pit (131-L) & Rubble Pile (131-3L) & Gas Cylinder Disposal Facility (131-2L) ROD** | **WSRC-RP-98-4195** | **1.1** | **February 17, 2003** |
| A-Area Burning/Rubble Pits (731-A/1A) and Rubble Pit (731-2A) ESD | WSRC-RP-2001-4281 | 1 | March 10, 2003 |
| R-Area Bingham Pump Outage Pits (643-8G, 643-9G and 643-10G) and R-Area Unknown Pits #1, #2, and #3 ROD | WSRC-RP-2001-4129 | 1.1 | April 28, 2003 |
| TNX Area Groundwater Operable Unit ESD[c] | WSRC-RP-2001-00764 | 0 | May 19, 2003 |
| Central Shops Burning/Rubble Pits (631-1G and 631-3G) ROD | WSRC-RP-2001-4265 | 1.1 | June 30, 2003 |
| P-Area Burning/Rubble Pit (131-P) ROD | WSRC-RP-2000-4197 | 1 | August 8, 2003 |
| A-Area Miscellaneous Rubble Pile (731-6A) ROD | WSRC-RP-2001-4197 | 1.3 | August 11, 2003 |
| P-Area Reactor Seepage Basin (904-61G, 904-62G, 904-63G) Plug-In ROD ESD | WSRC-RP-2002-4105 | 1.1 | October 2, 2003 |
| **Chemical, Metals, and Pesticides Pits Second Interim ROD Amendment** | **WSRC-RP-2001-4232** | **1.1** | **October 21, 2003** |
| L-Area Hot Shop (717-G) ROD | WSRC-RP-2002-4025 | 1.1 | November 3, 2003 |
| Road A Chemical Basin (904-111G) ROD | WSRC-RP-2002-4153 | 0 | November 3, 2003 |
| ***Second Five-Year Remedy Review***[c] | ***WSRC-RP-2001-4163*** | ***1.1*** | ***February 12, 2004*** |
| **R-Area Reactor Seepage Basins (904-57G, 904-58G, 904-59G, 904-60G, 904-103G, 904-104G and 108-4R Overflow Basin) ROD** | **WSRC-RP-2003-4093** | **1** | **March 18, 2004** |
| TNX Burying Ground (643-G), New TNX Seepage Basin, Old TNX Seepage Basin and TNX Groundwater (082-G) ROD | WSRC-RP-2003-4017 | 1 | April 7, 2004 |
| SRL Oil Test Site (808-16G) ROD | WSRC-RP-2003-4164 | 1 | September 20, 2004 |
| R-Area Burning/Rubble Pits (131-R, 131-1R) and Rubble Pile (631-25G) ROD | WSRC-RP-2004-4004 | 1 | September 28, 2004 |
| **C-Area Reactor Groundwater IROD** | **WSRC-RP-2004-4022** | **1** | **October 15, 2004** |

## Table A-3. Chronology of All RODs, IRODs, EARODs, ROD Amendments, and ESDs Issued at SRS *(continued)*

| Document Title[a] | Document Number | Rev. | Issuance Date[b] |
|---|---|---|---|
| D-Area Expanded Operable Unit (Consisting of D-Area Ash Basin, 488-D and D-Area Rubble Pit, 431-2D) ROD | WSRC-RP-2004-4007 | 1 | December 17, 2004 |
| Old F-Area Seepage Basin (904-49G) ROD Amendment | WSRC-RP-2003-4136 | 1 | December 17, 2004 |
| Heavy Equipment Wash Basin and Central Shops Burning/Rubble Pit (631-5G) ROD | WSRC-RP-2003-4185 | 1.1 | January 28, 2005 |
| **Chemical, Metals, and Pesticides Pits ROD** | **WSRC-RP-2004-4090** | **1** | **May 10, 2005** |
| Silverton Road Waste Unit ESD | WSRC-RP-2004-4092 | 1.1 | June 16, 2005 |
| TNX Area OU ESD | WSRC-RP-2005-4030 | 1 | November 7, 2005 |
| Hydrofluoric Acid Spill (631-4G) ROD | WSRC-RP-2005-4000 | 0 | December 28, 2005 |
| T-Area OU ROD | WSRC-RP-2004-4070 | 1 | January 4, 2006 |
| K-Area Sludge Land Application Site (761-4G) and PAR Pond Sludge Land Application Site (761-5G) ROD | WSRC-RP-2005-4064 | 1 | June 30, 2006 |
| 211-FB Pu-239 Release (081-F) ROD | WSRC-RP-2005-4090 | 1 | September 18, 2006 |
| M-Area Inactive Process Sewer Lines (081-M) ROD | WSRC-RP-2006-4001 | 1 | April 26, 2007 |
| **L-Area Southern Groundwater ROD** | **WSRC-RP-2006-4052** | **1.1** | **May 9, 2007** |
| A-Area Burning/Rubble Pits and Rubble Pit (731-A, 731-1A, 731-2A) and the Miscellaneous Chemical Basin/Metals Burning Pit (731-4A, 731-5A) ROD | WSRC-RP-2005-4095 | 1.1 | August 2, 2007 |
| C-Area Burning/Rubble Pit (131-C) and Old C-Area Burning/Rubble Pit (NBN) ROD | WSRC-RP-2007-4082 | 1 | July 9, 2008 |
| ***Third Five-Year Remedy Review*** | ***WSRC-RP-2007-4063*** | ***1.1*** | ***January 28, 2009*** |
| P-Area Operable Unit Early Action ROD | WSRC-RP-2008-4037 | 1.1 | January 29, 2009 |
| M-Area Operable Unit ROD | WSRC-RP-2008-4030 | 1 | February 5, 2009 |
| M-Area Operable Unit ESD | SRNS-RP-2009-00406 | 1 | July 9, 2009 |
| P-Area Operable Unit Early Action ROD ESD | SRNS-RP-2009-00704 | 1 | October 27, 2009 |
| C-, K-, L- and R-Reactor Complexes Early Action ROD | SRNS-RP-2009-00707 | 1 | December 8, 2009 |
| E-Area Low Level Waster Facility (Slit Trench Disposal Units 1 and 2) Interim ROD | SRNS-RP-2009-00538 | 1 | January 22, 2010 |
| Early Construction and Operational Disposal Site L-1, N-2, P-2, R-1A, R-1B, R-1C ROD | SRNS-RP-2009-00072 | 1 | March 30, 2010 |
| E-Area Low Level Waste Facility (Slit Trench Disposal Units 1 and 2) ESD | SRNS-RP-2009-01128 | 1 | April 22, 2010 |
| P-Area Operable Unit ROD | SRNS-RP-2009-01368 | 1 | July 22, 2010 |

**Table A-3. Chronology of All RODs, IRODs, EARODs, ROD Amendments, and ESDs Issued at SRS *(continued/end)***

| Document Title[a] | Document Number | Rev. | Issuance Date[b] |
|---|---|---|---|
| Gunsite 218 Rubble Pile ROD | SRNS-RP-2010-00051 | 1 | October 22, 2010 |
| **R-Area Operable Unit ROD** | **SRNS-RP-2010-01062** | **1** | **April 20, 2011** |
| L-Area Northern Groundwater ROD | SRNS-RP-2011-00134 | 1 | June 20, 2011 |
| Gunsite 012 (including ECODS G-3) ROD | SRNS-RP-2010-01232 | 1 | June 27, 2011 |
| D-Area Operable Unit Early Action ROD | SRNS-RP-2010-00162 | 1.2 | September 26, 2011 |
| PAR Pond Unit: Lower Three Runs IOU Tail Portion (Middle and Lower Subunits) ESD | SRNS-RP-2012-00121 | 1 | September 13, 2012 |
| B-Area Operable Unit ROD | SRNS-RP-2012-00354 | 1 | April 16, 2013 |
| F-Area Tank Farm, Waste Tanks 17 and 20 Interim ROD | SRR-CWDA-2013-00111 | 1 | April 30, 2013 |
| TNX Area Operable Unit (Second ESD to the ROD) | SRNS-RP-2012-00205 | 1 | June 12, 2013 |
| F-Area Tank Farm (Tanks 18 and 19 ESD to the Interim ROD) | SRR-CWDA-2013-00007 | 1.1 | September 23, 2013 |
| ***Fourth Five-Year Remedy Review*** | ***SRNS-RP-2012-00011*** | ***1.1*** | ***February 4, 2014*** |
| Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit ROD | SRNS-RP-2013-00730 | 1 | April 21, 2014[d] |
| **L-Area Southern Groundwater Operable Unit (ESD to the ROD)** | **SRNS-RP-2012-00736** | **1** | **September 10, 2014** |
| F-Area Tank Farm (Tanks 5 and 6 ESD to the Interim ROD) | SRR-CWDA-2014-00008 | 1 | September 11, 2014 |
| C-Area Operable Unit Early Action ROD | SRNS-RP-2014-00836 | 1 | September 2, 2015 |
| ***Fifth Five-Year Remedy Review for SRS OUs with Native Soil Covers and/or LUCs*** | ***SRNS-RP-2014-00902*** | ***1*** | ***November 30, 2015*** |

a Shaded text identifies the SRS OUs evaluated in this report for the first phase of the fifth five-year review (i.e., native soil covers and/or LUCs).

b Unless otherwise noted, the Issuance Date represents the date that the public was notified that the Three-Party signed document was available.

c This is the last signature date instead of the Issuance Date.

d Redline Revision 1 ROD for the Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit was approved on April 11, 2014 by SCDHEC and April 21, 2014 by USEPA. Date shown is for the last approval date because the ROD has not been issued.

## Table A-4. Summary of No Remedial Actions at SRS OUs

| Operable Unit | Remedial Action |
|---|---|
| ***No Action/No Further Action*** | |
| 211-FB Pu-239 Release (081-F) | No Action |
| 716-A Motor Shops Seepage Basin (904-101G) | No Action |
| Burma Road Rubble Pit (231-4F) | No Action |
| Central Shops Burning/Rubble Pit (631-6G) | No Action |
| Central Shops Sludge Lagoon (080-24G) | No Action |
| C-, F-, K-, and P-Area Coal Pile Runoff Basins (189-C, 289-F, 189-K, 189-P) | No Further Action |
| Fire Department Hose Training Facility (904-113G) | No Action |
| Ford Building Waste Site (643-11G) | No Further Action (Removal) |
| Grace Road Site (631-22G) | No Action |
| Gunsite 113 Access Road Unit (631-24G) | No Action |
| Gunsite 218 Rubble Pile (621-23G) | No Action |
| Gunsite 720 Rubble Pit Unit (631-16G) | No Action |
| Hydrofluoric Acid Spill (631-4G) | No Action |
| K-Area and PAR Pond Sludge Land Application Site (761-4G and 761-5G) | No Action |
| L-Area Hot Shop (717-G) | No Further Action |
| L-Area Northern Groundwater (NBN) | No Action |
| M-Area West Unit (631-21G) | No Action |
| R-Area Acid/Caustic Basin (904-77G) | No Action |
| Road A Chemical Basin (904-111G) | No Action |
| SRL Oil Test Site (080-16G) | No Action |
| West of SRL "Georgia Fields" Site (631-19G) | No Action |
| ***No Action/No Further Action OUs Associated with OUs Requiring Remedial Action*** | |
| 108-4R Overflow Basin (108-4R) | No Further Action |
| Central Shops Burning/Rubble Pit (631-5G) | No Action |
| ECODS B-3 and B-5 (NBN) | No Further Action |
| ECODS G-3 (Adjacent to Gunsite 012) (NBN) | No Action |
| Gas Cylinder Disposal Facility (131-2L) | No Action |
| L-Area Burning/Rubble Pit (131-L) | No Action |
| L-Area Acid/Caustic Basin (904-79G) | No Action |
| Rubble Pile Across from Gunsite 012 (NBN) | No Action |
| ***RCRA Units that are No Further Action under CERCLA*** | |
| H-Area Hazardous Waste Management Facility (904-44G, -45G, -46G, -56G) | No Further Action (Low Permeability Cap) |
| Tank 105-C Hazardous Waste Management Facility (NBN) | No Further Action |
| F-Area Hazardous Waste Management Facility (904-41G, -42G, -43G) | No Further Action (Low Permeability Cap, In Situ S/S) |
| Mixed Waste Management Facility (643-28E) | No Further Action (Low Permeability Cap) |

## Table A-5. List of OU Subunits with Remedial Actions

| # | OU Subunits[a,b] | CERCLIS # |
|---|---|---|
| 1 | A-Area Burning/Rubble Pit, 731-1A | 28 |
| | A-Area Burning/Rubble Pit, 731-A | 28 |
| | A-Area Rubble Pit, 731-2A | 28 |
| | Miscellaneous Chemical Basin, 731-4A | 28 |
| | Metals Burning Pit, 731-5A | 28 |
| 2 | A-Area Miscellaneous Rubble Pile, 731-6A | 30 |
| 3 | A/M Area Groundwater | 36 |
| 4 | C-Area Burning/Rubble Pit, 131-C | 31 |
| | Old C-Area Burning/Rubble Pit, NBN | 31 |
| 5 | C-Area Groundwater | 82 |
| 6 | C-Area Operable Unit | 79 |
| 7 | C-Area Reactor Seepage Basin, 904-66G | 60 |
| | C-Area Reactor Seepage Basin, 904-67G | 60 |
| | C-Area Reactor Seepage Basin, 904-68G | 60 |
| 8 | Central Shops Burning/Rubble Pit, 631-1G | 50 |
| | Central Shops Burning/Rubble Pit, 631-3G | 50 |
| 9 | CMP Pit, 080-170G | 24 |
| | CMP Pit, 080-171G | 24 |
| | CMP Pit, 080-180G | 24 |
| | CMP Pit, 080-181G | 24 |
| | CMP Pit, 080-182G | 24 |
| | CMP Pit, 080-183G | 24 |
| | CMP Pit, 080-190G | 24 |
| 10 | C-, K-, L-Reactor Complexes | 79, 90, 91 |
| 11 | D-Area Burning/Rubble Pit, 431-D | 15 |
| | D-Area Burning/Rubble Pit, 431-1D | 15 |
| 12 | D-Area Ash Basin, 488-D | 67 |
| | D-Area Rubble Pit, 431-2D | 67 |
| 13 | D-Area Oil Seepage Basin, 631-G | 27 |
| 14 | D-Area Coal Pile Runoff Basin, 489-D | 63 |
| | D-Area Waste Oil Facility, 484-10D | 63 |
| | D-Area Asbestos Pit, 080-20G | 63 |
| | Combined Spills from 483-D and Associated Areas, NBN | 63 |
| | D-Area Process Sewer Lines as Abandoned, NBN | 63 |
| 15 | E-Area Low Level Waste Facility, 643-26E | 86 |
| 16 | ECODS L-1, NBN | 22 |
| | ECODS P-2, NBN | 22 |
| | ECODS R-1A, -1B, -1C, NBN | 22 |
| | ECODS N-2, NBN | 22 |
| 17 | F-Area Burning/Rubble Pit, 231-1F | 14 |
| | F-Area Burning/Rubble Pit, 231-2F | 14 |
| | F-Area Burning/Rubble Pit, 231-F | 14 |
| 18 | F-Area Groundwater Operable Unit (904-41G, 904-42G, 904-43G) | 8 |
| 19 | F-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-41G) | 6 |
| | F-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-42G) | 6 |
| | F-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-43G) | 6 |

**Table A-5. List of OU Subunits with Remedial Actions *(continued)***

| # | OU Subunits[a,b] | CERCLIS # |
|---|---|---|
| 20 | F-Area Retention Basin, 281-3F | 23 |
| 21 | F-Area Tank Farm, Waste Tanks 17 and 20 | 23 |
| | F-Area Tank Farm, Waste Tanks 18 and 19 | 23 |
| | F-Area Tank Farm, Waste Tanks 5 and 6 | 23 |
| 22 | Ford Building Seepage Basin, 904-91G | 58 |
| 23 | General Separations Area Consolidation Unit including Old Radioactive Waste Burial Ground(643-E) and Old Solvent Tanks (650-01E through 650-22E) | 32 |
| | Warner's Pond, 685-23G and Spill of 3/08/1978 of Unknown Seepage Basin Pipe Leak in H-Area Seepage Basin and Spill on 02/08/1978 of Unknown H-Area Process Sewer Line Cave-In, NBN | 32 |
| | H-Area Retention Basin, 281-3H and Spill of 5/01/1956 of Unknown Retention Basin Pipe Leak, NBN | 21 |
| | HP-52 Ponds, NBN | 21 |
| 24 | Gunsite 012 Rubble Pile, NBN | 78 |
| | Rubble Pile across from Gunsite 012, NBN | 78 |
| 25 | H-Area Groundwater OU | 9 |
| 26 | H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-44G) | 7 |
| | H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-46G) | 7 |
| | H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-45G) | 7 |
| | H-Area Hazardous Waste Management Facility (F-Area Seepage Basin, 904-56G) | 7 |
| 27 | Heavy Equipment Wash Basin, NBN | 25 |
| 28 | Heavy Water Components Test Reactor (HWCTR), Building 770-U | 53 |
| 29 | K-Area Bingham Pump Outage Pit, 643-1G | 20 |
| 30 | K-Area Burning/Rubble Pit, 131-K | 40 |
| | K-Area Rubble Pile, 631-20G | 40 |
| 31 | K-Area Reactor Seepage Basin, 904-65G | 55 |
| 32 | L-Area Bingham Pump Outage Pit, 643-2G | 26 |
| | L-Area Bingham Pump Outage Pit, 643-3G | 26 |
| | P-Area Bingham Pump Outage Pit, 643-4G | 39 |
| 33 | L-Area Burning/Rubble Pit, 131-L | 56 |
| 34 | L-Area Oil Chemical Basin, 904-83G | 17 |
| 35 | L-Area Reactor Seepage Basin, 904-64G | 65 |
| 36 | L-Area Southern Groundwater, NBN | 77 |
| 37 | M-Area Hazardous Waste Management Facility: Lost Lake, 904-112G) | 1 |
| | M-Area Hazardous Waste Management Facility: M-Area Settling Basin, 904-51G | 1 |
| 38 | M-Area Settling Basin Inactive Process Sewers to Manhole 1, (081-M) | 19 |
| 39 | Inactive Clay Process Sewer Lines (Including Potential Release of TCT, TET, TCE, $HNO_3$, U, Heavy Metals from 321-M Abandoned Sewer Line), NBN | 92 |
| | Salvage Yard, 741-A | 92 |
| | M-Area Underground Sump 321-M #001 | 92 |
| | M-Area Underground Sump 321-M #002 | 92 |
| | M-Area Test Pile Facility, 305-A | 92 |
| 40 | Metallurgical Laboratory Hazardous Waste Management Facility (904-110G) | 2 |
| 41 | Mixed Waste Management Facility, 643-28E | 33 |
| 42 | Old F-Area Seepage Basin, 904-49G | 16 |
| 43 | PAR Pond (including the Pre-Cooler Ponds and Canals), 685-G | 35 |
| | PAR Pond: Lower Three Runs Integrator Operable Unit Tail Portion (Middle and Lower Subunits) | 35 |

**Table A-5. List of OU Subunits with Remedial Actions *(continued)***

| # | OU Subunits[a,b] | CERCLIS # |
|---|---|---|
| 44 | P-Area Burning/Rubble Pit, 131-P | 59 |
| 45 | P-Area Ash Basin (including Outfall P-007), 188-P | 94 |
| | Potential Release from P-Area Disassembly Basin, NBN | 94 |
| | Potential Release from P-Area Reactor Cooling Water System, 186/190-P | 94 |
| | P-Area Reactor Area Cask Car Railroad Tracks as Abandoned, NBN | 94 |
| | P-Area Process Sewer Lines as Abandoned, NBN and Spill on 3/15/79 of 5500 Gallons of Contaminated Water, NBN | 94 |
| 46 | P-Area Reactor Seepage Basin, 904-61G | 66 |
| | P-Area Reactor Seepage Basin, 904-62G | 66 |
| | P-Area Reactor Seepage Basin, 904-63G | 66 |
| 47 | R-Area Bingham Pump Outage Pit, 643-10G | 38 |
| | R-Area Bingham Pump Outage Pit, 643-8G | 38 |
| | R-Area Bingham Pump Outage Pit, 643-9G | 38 |
| | R-Area Unknown Pit #1 (Runk-1), NBN | 38 |
| | R-Area Unknown Pit #2 (Runk-2), NBN | 38 |
| | R-Area Unknown Pit #3 (Runk-3), NBN | 38 |
| 48 | R-Area Burning/Rubble Pit, 131-1R | 43 |
| | R-Area Burning/Rubble Pit, 131-R | 43 |
| | R-Area Rubble Pit, 631-25G | 43 |
| 49 | Area on the North Side of Building 105-R | 95 |
| | Laydown Area North of 105-R | 95 |
| | R-Area Cooling Water Effluent Sump, 107-R | 95 |
| | Potential Release of $NaOH/H_2SO_4$ from 183-2R, NBN | 95 |
| | R-Area Ash Basin, 188-R | 95 |
| | Potential Release from R-Area Disassembly Basin, NBN | 95 |
| | R-Area Reactor Area Cask Car Railroad Tracks as Abandoned, NBN | 95 |
| | Release from the Decontamination of R-Reactor Disassembly Basin, NBN | 95 |
| | Combined Spills North of Building 105-R, NBN | 95 |
| | R-Area Process Sewer Lines as Abandoned, NBN | 95 |
| | R-Area Reactor Building, 105-R | 95 |
| 50 | R-Area Reactor Seepage Basin, 904-103G | 25 |
| | R-Area Reactor Seepage Basin, 904-104G | 25 |
| | R-Area Reactor Seepage Basin, 904-57G | 25 |
| | R-Area Reactor Seepage Basin, 904-58G | 25 |
| | R-Area Reactor Seepage Basin, 904-59G | 25 |
| | R-Area Reactor Seepage Basin, 904-60G | 25 |
| 51 | Silverton Road Waste Unit, 731-3A | 13 |
| 52 | SRL Seepage Basin, 904-53G1 | 47 |
| | SRL Seepage Basin, 904-53G2 | 47 |
| | SRL Seepage Basin, 904-54G | 47 |
| | SRL Seepage Basin, 904-55G | 47 |

**Table A-5. List of OU Subunits with Remedial Actions *(continued/end)***

| # | OU Subunits[a,b] | CERCLIS # |
|---|---|---|
| 53 | Neutralization Sump, 678-T | 96 |
| | X-001 Outfall Drainage Ditch, NBN | 96 |
| | TNX Outfall Delta, Lower Discharge Gully and Swamp, NBN | 96 |
| | TNX-Area Process Sewer Lines and Tile Fields as Abandoned, NBN | 96 |
| 54 | TNX Groundwater, 082G | 21 |
| | New TNX Seepage Basin, 901-102G | 29 |
| | Old TNX Seepage Basin, 904-76G | 29 |
| | TNX Burying Ground, 643-5G (Including Spill on 1/12/53 of ½ Ton of Uranyl Nitrate, NBN) | 29 |
| 55 | Wetland Area at Dunbarton Bay[c] | 71 |

a OU subunits include RCRA/CERCLA units and RCRA regulated units. Deactivation & Decommissioning facilities are not represented.

b Shaded text identifies the SRS OUs evaluated in this report for the second phase of the fifth five-year review (i.e., groundwater).

c Redline Revision 1 ROD for the Wetland Area at Dunbarton Bay in Support of Steel Creek Integrator Operable Unit was approved on April 11, 2014 by SCDHEC and April 21, 2014 by USEPA. Date shown is for the last approval date because the ROD has not been issued.

## EVALUATION OF CHANGES IN STANDARDS AND TOXICITY

This appendix provides an evaluation of changes in standards and toxicity for chemical and radiological constituents since the last five-year remedy review was initiated in 2012 for the seven Savannah River Site (SRS) operable units (OUs) evaluated in this report. The purpose of the evaluation is to determine if there are any changes in standards or toxicity values that would call into question the protectiveness of the remedy. No protectiveness issues with respect to changes in standards and toxicity were identified in the previous five-year remedy review report (SRNS 2014).

An evaluation was performed for analytes that were identified as constituents of concern (COCs) for the seven OUs evaluated. As discussed in Appendix A, the seven OUs evaluated in this report were grouped in the Groundwater category because they have monitoring activities associated with Monitored Natural Attenuation or a Mixing Zone permit. However, these OUs may also have subunits with COCs in soil or building material (concrete and metal) media in addition to groundwater as documented in the respective remedy selection documents. For this reason, an evaluation of changes in standards and toxicity values for chemical and radiological COCs identified in soil, concrete, and groundwater media is shown in Tables B-1 through B-6.

The United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Non Radiological Constituents (June 2015), USEPA Preliminary Remediation Goals (PRGs) for Radionuclides (November 2014), USEPA Building Preliminary Remediation Goals (BPRGs) for Radionuclides (September 2014), and USEPA Maximum Contaminant Levels (MCLs) for radiological and chemical constituents were evaluated in this review. These values are identified as 2015 RSLs, 2015 PRGs, 2015 BPRGs, or MCLs in Tables B-1 through B-6 and were compared to the values available in 2012 when the last five-year remedy review was initiated. Standards and toxicity values for both the industrial worker and hypothetical residential receptor are provided for comparative purposes for most media.

The comparison tables do not make any distinction between COCs that were the primary drivers for the selected remedial action and other analytes that were simply addressed through the same remedy. Most importantly, the values presented in Tables B-1 through B-6 are not cleanup levels and should not be considered remedial goals unless otherwise noted in the OU-specific remedy reviews. For these reasons, the information in Appendix B is not stand alone, but must be considered in context with the information and selected remedy presented in the OU-specific reviews located in Appendix C through Appendix I.

Changes to a standard or toxicity factor is unique to each analyte and is often related to revisions in exposure assumptions, reference doses, cancer potency factors, and exposure pathways used to calculate the value. For the reasons explained in the previous paragraph, the impact that more stringent RSLs or PRGs have on protectiveness must be considered with respect to the OU-specific remedy. In most cases, a change in a standard or toxicity value is irrelevant because the analyte(s) may no longer be present or is (are) significantly reduced if the selected remedy also included excavation and offsite disposal. In addition, exposure to contaminants may be controlled by a cover system.

The evaluation for each remedy to determine if exposure assumptions, toxicity data, cleanup levels, and remedial action objectives are still valid is discussed in each OU-specific review located in Appendix C through Appendix I. The evaluations shown in Tables B-1 through B-6 confirm that there have been no significant changes in standards or toxicity factors that would affect the protectiveness of the remedies evaluated in this report.

## DOCUMENTS REVIEWED

SRNS, 2014. *Fourth Five-Year Remedy Review Report for the Savannah River Site (U) Aiken, South Carolina*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

## Table B-1. Comparison of Nonradiological Standards in Soil Media

| Analyte | 2012 RSLs[a] | | 2015 RSLs[b] | | CERCLIS Number(s)[c] |
|---|---|---|---|---|---|
| | Residential Soil (mg/kg) | Industrial Worker Soil (mg/kg) | Residential Soil (mg/kg) | Industrial Worker Soil (mg/kg) | |
| Arsenic | 3.9E-01 | 1.6E+00 | 6.8E-01 | 3.0E+00 | 95 |
| Cadmium | 7.0E+01 | 8.0E+02 | 7.1E+01 | 9.8E+02 | 56 |
| Copper | 3.1E+03 | 4.1E+04 | 3.1E+03 | 4.7E+04 | 56 |
| p,p'-DDD | 2.0E+00 | 7.2E+00 | 2.3E+00 | 9.6E+00 | 24 |
| p,p'-DDE | 1.4E+00 | 5.1E+00 | 2.0E+00 | 9.3E+00 | 24 |
| p,p'-DDT | 1.7E+00 | 7.0E+00 | 1.9E+00 | 8.5E+00 | 24 |
| Dieldrin | 3.0E-02 | 1.1E-01 | 3.4E-02 | 1.4E-01 | 24 |
| Endrin | 1.8E+01 | 1.8E+02 | 1.9E+01 | 2.5E+02 | 24 |
| Heptachlor epoxide | 5.3E-02 | 1.9E-01 | 7.0E-02 | 3.3E-01 | 24, 95 |
| Lead | 4.0E+02 | 8.0E+02 | 4.0E+02 | 8.0E+02 | 56 |
| Mercury | 1.0E+01 | 4.3E+01 | 9.4E+00 | 4.0E+01 | 56 |
| Methylene Chloride | 5.6E+01 | 9.6E+02 | 5.7E+01 | 1.0E+03 | 24 |
| Aroclor 1254 | 2.2E-01 | 7.4E-01 | 2.4E-01 | 9.7E-01 | 56 |
| Aroclor 1260 | 2.2E-01 | 7.4E-01 | 2.4E-01 | 9.9E-01 | 24 |

a USEPA Nonradiological RSLs, May 2012.
b USEPA Nonradiological RSLs, June 2015.
c OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

mg/kg = milligram per kilogram

## Table B-2. Comparison of Radiological Standards in Soil Media

| Analyte | 2012 PRGs[a] | | 2015 PRGs[b] | | CERCLIS Number(s)[c] |
|---|---|---|---|---|---|
| | Residential Soil (pCi/g) | Industrial Worker Soil (pCi/g) | Residential Soil (pCi/g) | Industrial Worker Soil (pCi/g) | |
| Americium-241 | 1.9E+00 | 4.8E+E00 | 2.3E+00 | 4.7E+00 | 25 |
| Carbon-14 | 2.8E+02 | 1.1E+03 | 3.2E+02 | 1.1E+03 | 25 |
| Cerium-137 | 4.7E+04 | 6.8E+04 | 3.6E+04 | 5.3E+04 | 25 |
| Cesium-137+D | 6.3E-02 | 1.0E-01 | 6.1E-02 | 9.1E-02 | 95 |
| Cobalt-60 | 3.9E-02 | 5.8E-02 | 3.3E-02 | 4.8E-02 | 25, 95 |
| Plutonium-238 | 3.2E+00 | 1.4E+01 | 4.3E+00 | 1.4E+01 | 25 |
| Plutonium-239 | 2.8E+00 | 1.3E+01 | 3.8E+00 | 1.2E+01 | 25 |
| Plutonium-240 | 2.8E+00 | 1.3E+01 | 3.8E+00 | 1.2E+01 | 25 |
| Radium-226+D | 1.3E-02 | 2.2E-02 | 1.4E-02 | 2.1E-02 | 95 |
| Strontium-90+D | 3.7E+00 | 8.9E+00 | 4.2E+00 | 9.0E+00 | 25, 95 |
| Uranium-235(+D) | 1.9E-01 | 3.5E-01 | 1.9E-01 | 3.0E-01 | 95 |
| Uranium-238(+D) | 7.3E-01 | 1.5E+00 | 8.0E-01 | 1.4E+00 | 95 |

a USEPA Radiological PRGs, August 2010.
b USEPA Radiological PRGs, November 2014.
c OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

mg/kg = milligram per kilogram
pCi/g = picoCuries per gram

## Table B-3. Comparison of Radiological Standards in Concrete Media

| Analyte | 2012 PRGs[a] Industrial Worker Concrete (pCi/g) | 2015 BPRGs[b] Industrial Worker Concrete (pCi/g) | CERCLIS Number(s)[c] |
|---|---|---|---|
| Americium-241 | 7.8E+00 | 6.0E+00 | 95 |
| Americium-243+D | 3.4E-01 | 2.7E-01 | 95 |
| Barium-133 | 3.1E-01 | 3.0E-01 | 95 |
| Cesium-137+D | 1.1E-01 | 1.2E-01 | 95 |
| Cobalt-60 | 6.0E-02 | 7.0E-02 | 95 |
| Europium-152 | 7.4E-02 | 7.0E-02 | 95 |
| Nickel-63 | 5.6E+04 | -- [d] | 95 |
| Silver-108m | 3.3E-02 | 3.2E-02 | 95 |
| Strontium-90(+D) | 1.4E+01 | 7.3E+00 | 95 |

a Prior to the availability of USEPA BPRGs, radiological standards in concrete were based on industrial worker radiological PRG values for concrete media documented in *Radionuclide Preliminary Remediation Goals for Concrete Media*, Engineering Calculation K-CLC-00086, Rev.0, 11/05.
b USEPA Radiological BPRGs, September 2014.
c OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.
d PRG for Ni-63 was not published in the September 2014 update.

pCi/g = picoCuries per gram

## Table B-4. Comparison of Nonradiological Standards in Groundwater Media (RSLs)

| Analyte | 2012 RSL[a] (µg/L) | 2015 RSL[b] (µg/L) | CERCLIS Number[c] |
|---|---|---|---|
| alpha-Benzene hexachloride (α-BHC) | 6.2E-03 | 7.1E-03 | 24 |
| beta-Benzene hexachloride (β-BHC) | 2.2E-02 | 2.5E-02 | 24 |
| delta-Benzene hexachloride (δ-BHC) | 1.3E+04 | 1.3E+04 | 24 |
| Dieldrin | 1.5E-03 | 1.7E-03 | 24 |

a USEPA Nonradiological RSLs, May 2012.
b USEPA Nonradiological RSLs, June 2015.
c OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.

## Table B-5. Nonradiological Standards in Groundwater Media (MCLs)

| Analyte | MCL (µg/L)[a] | CERCLIS Number[b] |
|---|---|---|
| Aroclor-1254 | 0.5[c] | 95 |
| Benzene | 5 | 27 |
| Bis(2-ethylhexl) phthalate (BEHP) | 6 | 24 |
| Carbon tetrachloride | 5 | 24, 56, 95 |
| 1,1-Dichloroethene (1,1-DCE) | 7 | 27 |
| Chloroform | 80 | 95 |
| cis-1,2-Dichloroethene (cis-1,2-DCE) | 70 | 27, 95 |
| Dichloromethane (Methylene chloride) | 5 | 24, 27 |
| Lead | 15[c] | 95 |
| Lindane | 0.2 | 24 |
| Tetrachloroethylene (PCE) | 5 | 24, 27, 77 |
| Trichloroethylene (TCE) | 5 | 24, 27, 77, 82, 95 |
| Trihalomethanes (Total) | 80 | 24, 56 |
| Vinyl chloride (VC) | 2 | 27, 95 |

a Current MCL table is provided for reference only. Comparative analysis is not shown because MCLs have not changed since the previous five-year remedy review.
b OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.
c MCL used for contaminant migration analysis. Constituent is not a groundwater COC.

## Table B-6. Radiological Standards in Groundwater Media (PRGs/MCLs)

| Analyte | 2012 PRG (pCi/L)[a] | 2015 PRG (pCi/L)[b] | MCL (pCi/L)[c] | CERCLIS Number[d] |
|---|---|---|---|---|
| Americium-241 | -- | -- | 15[e] | 25 |
| Chlorine-36 | -- | -- | 700[d] | 95 |
| Molybdenum-93 | 14.2[f] | 6.8[f] | -- | 95 |
| Nickel-59 | -- | -- | 300[d] | 95 |
| Niobium-94 | 6.1[f] | 4.2[f] | -- | 95 |
| Potassum-40 | 1.9[f] | 0.8[f] | -- | 95 |
| Strontium-90 | -- | -- | 8[g] | 25 |
| Tritium | -- | -- | 20,000[g] | 77, 95 |

a USEPA Radiological PRGs, August 2010.
b USEPA Radiological PRGs, June 2015.
c USEPA Radioactivity in Drinking Water, Appendix III (January 1981). Comparative analysis is not shown for MCLs because standards have not changed since the previous five-year remedy review.
d OUs and corresponding CERCLIS number(s) are identified in Appendix A, Table A-5.
e Gross alpha particle activity = 15 pCi/L
f PRG used for contaminant migration analysis. Constituent is not a groundwater COC.
g Man-made beta/gamma emitters = 4 mrem/year dose

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# C-AREA GROUNDWATER OPERABLE UNIT

## I. Introduction

This is the third five-year review for the C-Area Groundwater (CAGW) Operable Unit (OU) and discusses the interim action that addressed volatile organic compound (VOC) contamination in soil and groundwater. This review was conducted from August 2015 through November 2015 and documents the results of the review. Contaminants have been left in place at the CAGW OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the interim action remedy in place at the CAGW OU is protective of human health and the environment.

## II. OU Chronology

Table C-1 lists the chronology of site events for the CAGW OU.

## III. Background

CAGW OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) (FFA 1993). The media associated with the CAGW OU is the vadose zone soil (source area), surface water, and groundwater.

### Physical Characteristics

CAGW OU is located in the west-central portion of the SRS, entirely within the Fourmile Branch watershed (Figure C-1). CAGW OU encompasses groundwater below C Area, north to unnamed tributaries of Fourmile Branch, west to Fourmile Branch, and south to Castor Creek (Figure C-2), which comprises approximately 3.29 km$^2$ (1.27 mi$^2$).

The hydrogeologic conceptual site model for the interim action for the CAGW OU depicts contamination from VOCs, primarily trichloroethylene (TCE), above their respective maximum contaminant levels (MCLs). The VOC contamination originated in C Area from reactor operations and migrated through the vadose zone to the Transmissive Zone (TZ) of the Upper Three Runs Aquifer (UTRA). Contaminants in the TZ are readily transported west toward Fourmile Branch and to the south towards Castor Creek. Below the TZ is the Tan Clay Confining Zone (TCCZ), which is composed of the Upper Tan Clay Layer, the Middle Aquifer Zone (MAZ), and a Tan Clay Lower Clay layer. The TCCZ inhibits downward migration of contaminants into the Lower Aquifer Zone (LAZ) of the UTRA. However, the Upper Tan Clay Layer is discontinuous in places and downward contaminant migration does occur, primarily contaminating the MAZ and to a lesser extent the LAZ. The contaminated groundwater in the MAZ and LAZ discharges into Fourmile Branch or Castor Creek (SRNS 2014a). TCE does not exceed the MCL in surface water in either Castor Creek or Fourmile Branch.

CAGW OU is currently monitored by the following:

- Forty-eight groundwater monitoring wells;
- Five seepline monitoring stations; and
- Thirteen surface water sampling stations.

Periodic groundwater monitoring in CAGW OU began in 1983 and continues to the present. The VOC contamination in C-Area groundwater that originated from the C-Area Burning/Rubble Pit (CBRP) OU, mainly TCE and tetrachloroethylene (PCE), is being addressed by the CBRP OU.

### Land and Resource Use

The CAGW OU sources are located within an industrial use area, but the distal portion of the groundwater plume extends beyond the industrial use boundary. However, shallow groundwater and surface water at SRS are not used for drinking water, hygiene, recreation, or process water. According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The future land use for the CAGW OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

**History of Contamination**

C-Reactor operated from March 1955 until June 1985; C-Reactor was placed in cold standby in 1987. TCE was released to the soil at a manhole along a storm sewer line south of the C-Reactor Building (105-C). Characterization during 1998 to 2002 determined a TCE groundwater plume extending from the C-Reactor Building (105-C) to Castor Creek, where the TCE plume discharges south of C Area. Figure C-3 shows the location of the TCE vadose zone (the unsaturated zone above the water table) source relative to the reactor building, the location of soil borings, and monitoring well data in 2002. An Interim Record of Decision (IROD) for the TCE vadose zone source area was issued on October 15, 2004 (WSRC 2004a). The interim remedial action selected in the IROD was Electrical Resistance Heating (ERH) with Soil Vapor Extraction (SVE) and was implemented from June through September 2006. The purpose of the interim remedial action was to reduce vadose zone TCE concentrations to levels that would not exceed the MCL (5 μg/L), if the contaminant leached into the groundwater. Soil data collected in October 2006 determined that the ERH with SVE interim action was successful. Likewise, soil data collected in 2011 verified that the interim remedial action continues to be protective of the groundwater. Groundwater monitoring during 2012 to 2015 found that TCE concentrations are still above its MCL (5 μg/L) but declining (Figure C-4). PCE has been below its MCL (5 μg/L) since 2006.

Tritium was produced during the operation of the reactor and was released from numerous sources. No tritium has been produced since C-Reactor was shut down in June 1985. Other than atmospheric releases, the two primary discharge areas for tritium were the C-Area Discharge Canal and the C-Area Reactor Seepage Basins (CRSBs). Characterization data indicated contaminants released to the C-Area Discharge Canal from C-Reactor operations were carried by high discharge flows to Fourmile Branch. The CRSBs, a known historical source of tritium and other radionuclides, were remediated using low-permeability grout stabilization of basin soils as documented in the

*Post-Construction Report/Final Remediation Report for the C-Area Reactor Seepage Basins (904-66G, -67G, and -68G) Operable Unit* (WSRC 2003). Although tritium concentrations are still above the MCL (20 pCi/ml), groundwater and surface water data collected in 2013 and 2014 indicate the size and concentration of the CAGW OU tritium plume has significantly decreased relative to the original 1998 to 2002 characterization (SRNS 2014a). The IROD does not address tritium in the groundwater and is therefore, not part of this remedy review. However, tritium will continued to be monitored to document the decreasing trend and will be addressed in the final CAGW OU ROD scheduled to be issued in March 2020.

**Initial Response**

The nature and extent of groundwater contamination within the CAGW OU was comprehensively investigated between 1998 and 2002. The results were presented in the RCRA Facility Investigation (RFI)/Remedial Investigation (RI) Report (WSRC 2004b).

**Basis for Taking Action**

The RFI/RI characterization data indicated that groundwater concentrations of TCE, in the vicinity of the manhole along a storm sewer line south of the C-Reactor Building (105-C), exceeded its MCL (5 µg/L) by 2,600 times. The 2015 TCE plume (Figure C-4) extends from south of the C-Reactor Building to over 1.6 km (1 mi) downgradient to Castor Creek. In 2002, residual TCE (maximum = 51.846 mg/kg) in the vadose zone soil was present at levels that were still impacting groundwater. Although shallow groundwater aquifers at SRS are not used as a drinking water source, the potential for unacceptable human exposure to contaminated groundwater exists as long as TCE remains above its MCL. Thus, control of the migration of TCE was necessary through a source control action. The geometry of the TCE vadose zone source is a vertical cylinder approximately 18 m (60 ft) in diameter extending 21 m (70 ft) below ground surface.

## IV. Remedial Actions

### Remedy Selection

As stated in the IROD for the CAGW OU (WSRC 2004a), the interim remedial action objective (RAO) is to reduce TCE concentrations in the vadose zone so that any leaching of the contaminant will not cause groundwater to exceed the MCL (5 μg/L). The selected interim action remedy was ERH with SVE. The constituents of concern and remedial goals selected for the interim action are provided in Table C-2.

Tritium contamination in groundwater and surface water was not addressed in the IROD (WSRC 2004a). The final remedial action for the tritium and VOC contamination at the CAGW OU will be documented in the final CAGW OU ROD scheduled to be issued in March 2020.

### Remedy Implementation

Implementation of the interim remedial action consisted of the following activities:

- Installed ERH system with a single six-phase heating array consisting of six input electrode/SVE wells equally spaced around the circumference of a 9-m (30-ft) diameter circle. A central neutral electrode/SVE well was centered on the highest contaminant levels in the TCE source. Two SVE wells and two electrodes were installed in a single large well boring at each of the seven locations. An electrolyte addition system was installed.

- Installed an active SVE unit skid consisting of a 300 $ft^3$/min blower, condensate tank, knockout pot, water/vapor separator, heat exchanger and cooling tower.

ERH used the electrical resistance of soil to heat the soil in situ using an electrical current. The electrolyte drip tube was used to provide the means to inject an electrolyte solution into the electrode to increase conductivity between the electrode and the soil interface. The heat vaporized VOCs in the soil. These vapors were withdrawn by the SVE system, via a manifold to a vacuum pumping system, treated and discharged per an air quality control permit. Figure C-5 is a generalized graphic of an ERH with SVE system.

**Systems Operations/Operation and Maintenance**

Currently, there are no remedial systems operating. ERH with SVE operated from June 15, 2006 until the IROD shutdown criterion was met on September 7, 2006. The SVE system continued to operate until September 28, 2006. The shutdown criterion was met when the temperature in the treatment zone exceeded 189ºF (boiling point of TCE) for at least 30 days cumulatively.

The following actions will be conducted at the CAGW OU until the scheduled FFA final remedial action start date of June 2021:

- Groundwater monitoring as required by the Interim Remedial Action Implementation Plan Effectiveness Monitoring Plan (WSRC 2005). The groundwater wells CRW020D, CRW021DR, and CRW-1D (background) are monitored groundwater TCE and tritium concentrations, which are performance measures of the completed ERH system operations.

Costs associated with the selected interim remedy for the CAGW OU include operation and maintenance (O&M) costs as reported in the IROD (WSRC 2004a). ERH with SVE activity was completed in 2006 and the remaining O&M cost is associated with groundwater monitoring. The estimated O&M cost since the last remedy review is $174,000 for FY2012 through FY2015 and is based on the IROD estimate for monitoring of the ERH with SVE system for six years. The actual operation and maintenance cost for the same time period is $36,133. The actual O&M costs (Table C-3) for performance/groundwater monitoring was less than expected because the required length of monitoring of the ERH with SVE system was shortened from six years (estimated completion in FY2013) to one year (actual completion in FY2007). On-going groundwater monitoring costs beyond FY2013 were not included in the original IROD cost estimate.

## V. Progress since Last Review

The previous protectiveness statement concluded that the interim remedial action at CAGW OU is protective of human health and the environment, and in the interim, exposure pathways that could result in unacceptable risks are being controlled by SRS institutional controls (e.g., fences, guards, security patrols, SRS Site Use/Site Clearance Program), environmental monitoring, and site inspection and maintenance.

Soil data collected in 2011 determined that the interim remedial action of ERH with SVE at CAGW OU continues to be protective of the groundwater. In 2011, residual TCE (maximum = 1.064 mg/kg) in the vadose zone soil was below levels that would impact groundwater. In 2012, the maximum groundwater TCE concentration was 1,770 µg/L, and it has decreased to 260 µg/L in 2015 (Figure C-6). The groundwater monitoring network has been functioning properly.

There were no recommendations or follow-up actions from the last five-year review.

## VI. Five-Year Review Process

The following tasks were performed as part of the five-year review:

- Reviewed the documents listed in Section XII, Documents Reviewed,
- Confirmed implementation and completion of the interim remedial action,
- Reviewed all process and performance monitoring data provided by the annual effectiveness reports and provided a technical assessment of whether the ERH with SVE functioned as intended by the IROD and whether the shutdown criteria has been achieved;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist, provided in Attachment C-1, with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and

- Reviewed changes in standards and to-be-considered guidance.

*Data Review*

Groundwater and surface water data collected from 2013 to 2015 indicate the concentration of the CAGW OU TCE plume has significantly decreased relative to the original 1998 to 2002 characterization. In 2015, the TCE plume has also decreased in extent relative to the original 1998 to 2002 characterization. Groundwater monitoring wells (CRW 20D and CRW021DR) near the TCE vadose zone source area indicate decreasing TCE concentrations since the completion of the ERH with SVE interim remedy (Figure C-6). Review of the surface water data confirms TCE has not exceeded MCLs in Castor Creek or in Fourmile Branch since 2002 when monitoring began.

*Summary of Inspections and Interviews*

Interviews were conducted with Richard Feagin, O&M staff member, on July 15, 2015 at the CAGW OU and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The CAGW OU was inspected by Savannah River Nuclear Solutions, LLC and USDOE personnel on July 12, 2015 and November 3, 2015, respectively. No issues were identified for the CAGW OU during the inspection and interviews.

## VII. Technical Assessment

### Is the Remedy Functioning as Intended by the Decision Document?

The interim remedy is functioning as intended as demonstrated below:

- The ERH with SVE system was effective at reducing TCE concentrations in the vadose zone to a level that prevents TCE leaching from its MCL in the groundwater. The ERH with SVE system exceeded its shutdown criteria by operating longer (56 days) than the required minimum 30 days with soil temperatures above 189°F. After ERH was shutdown, SVE continued operating for an additional 21 days, to further decrease TCE levels. ERH with SVE removed a total of 730 lbs of TCE. Follow up soil sampling indicated that TCE removal efficiency from the vadose zone source was better than 99.2% after 85 days of ERH operation and 106 days of SVE operation (WSRC 2007). Average concentrations were reduced from 6.31 mg/kg to 0.039 mg/kg. Soil data collected in 2011 from both inside and outside the ERH target zone indicated that residual TCE in vadose zone soil does not present a contaminant migration threat to groundwater.

- Semiannual groundwater monitoring data collected since the last five-year remedy review indicate the TCE plume in the source area is decreasing in concentration (Figure C-6) relative to the RFI/RI characterization data (TCE maximum concentration = 13,100 µg/L) collected during 1998 to 2002. In 2015, the maximum groundwater TCE concentration was 260 µg/L.

**Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still Valid?**

There have been no changes in MCLs that would impact the interim remedy. An evaluation of the changes in toxicity data and risk methods are not relevant at this time as the baseline risk assessment to support a final action has not been conducted.

Due to the presence of chlorinated solvents at the CAGW OU, there was a concern that 1,4-dioxane may also exist in groundwater because the chemical is often added to chlorinated solvents as a stabilizer and corrosion inhibitor. As reported in the previous five-year remedy review report (SRNS 2014b), SRS performed a review of the ninety-eight (98) groundwater and surface water samples data for 1,4-dioxane. Based on the low frequency of detects, the scattered locations of those results, and the very low levels of the results, the USDOE, USEPA, and SCDHEC agreed that 1,4-dioxane was not a contaminant of concern for the CAGW OU that required additional monitoring.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No other information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

There are no issues for this OU.

## IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for this unit.

## X. Protectiveness Statement(s)

The interim remedy at the CAGW OU is protective of human health and the environment.

The interim action of ERH with SVE to prevent TCE in the vadose zone from leaching to groundwater above MCLs is complete. Groundwater monitoring indicates the interim remedial action was successful in preventing further groundwater impact. Until the final ROD for CAGW OU is issued, the exposure pathways that could lead to unacceptable risk are being restricted through SRS land use controls to include implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the CAGW OU for industrial use only, and use restrictions via the SRS Site Use/Site Clearance Program. Protectiveness of the interim remedial action will be verified by continued groundwater monitoring.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2014a. *Data Report for the C-Area Groundwater (CAGW) Operable Unit (OU) (U)*, SRNS-RP-2014-00835, Revision 0, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

SRNS, 2014b. *Fourth Five-Year Remedy Review Report for the Savannah River Site (U) Aiken, South Carolina*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 2003. *Post-Construction Report (PCR)/Final Remediation Report (FRR) for the C-Area Reactor Seepage Basin (904-66G, -67G, and -68G) Operable Unit (U)*, WSRC-RP-2002-4149, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004a. *Interim Record of Decision Remedial Alternative Selection for the Remediation of the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)*, WSRC-RP-2004-4022, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004b. *RCRA Facility Investigation/Remedial Investigation Report for the C-Area Reactor Groundwater (CRGW) Operable Unit*, WSRC-RP-2003-4073, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2005. *Interim Remedial Action Implementation Plan (IRAIP) for the Trichloroethylene Vadose Zone Source Unit at the C-Reactor Groundwater Operable Unit (U)*, WSRC-RP-2004-4114, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007. *Report on the Effectiveness of the TCE Vadose Source Unit at C Reactor Groundwater (VCRGW) OU Interim Remedial Action*, WSRC-RP-2007-4006, Revision 1, Washington Savannah River Company, Aiken, SC

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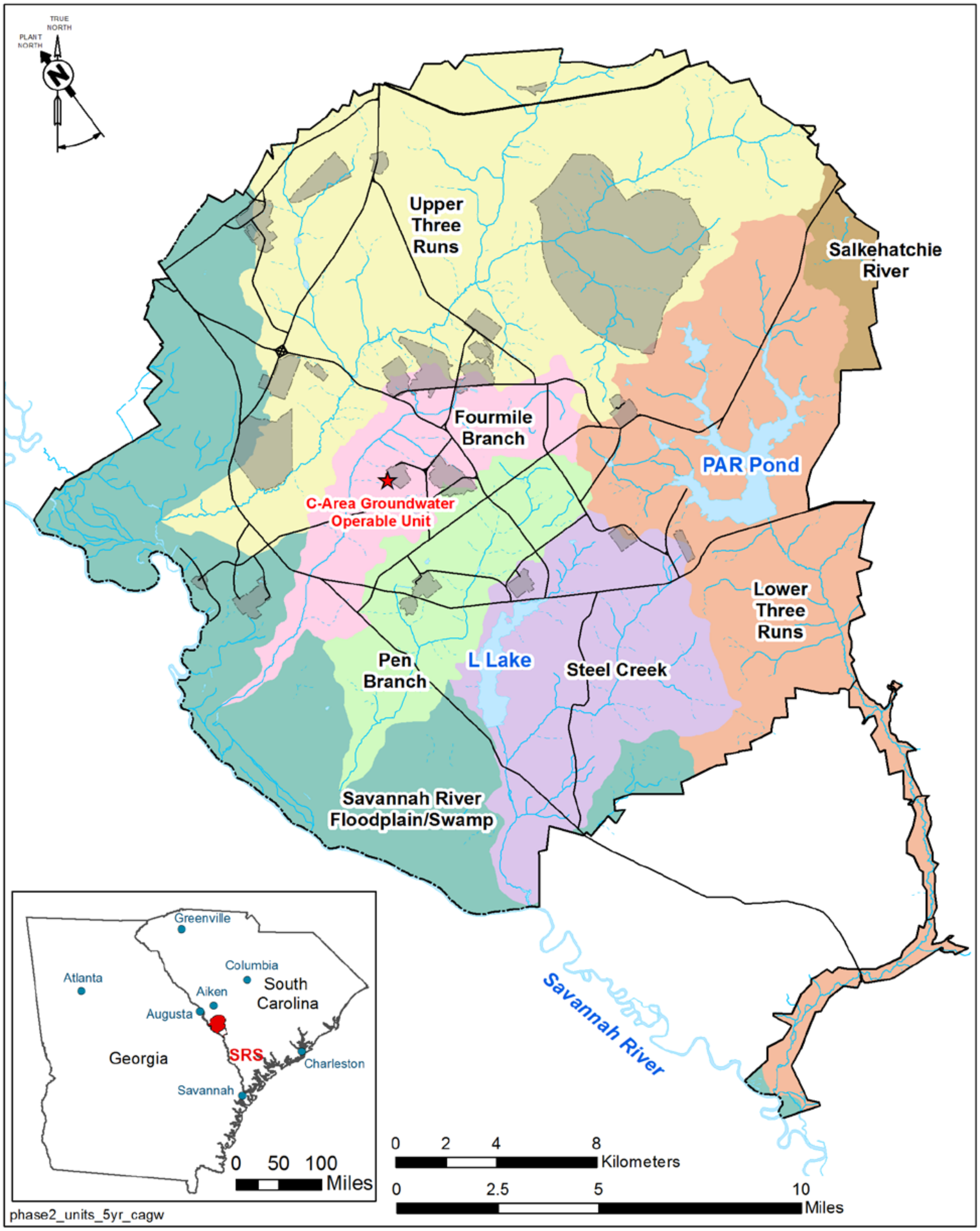


**Figure C-1. Location of the CAGW OU within the Savannah River Site**

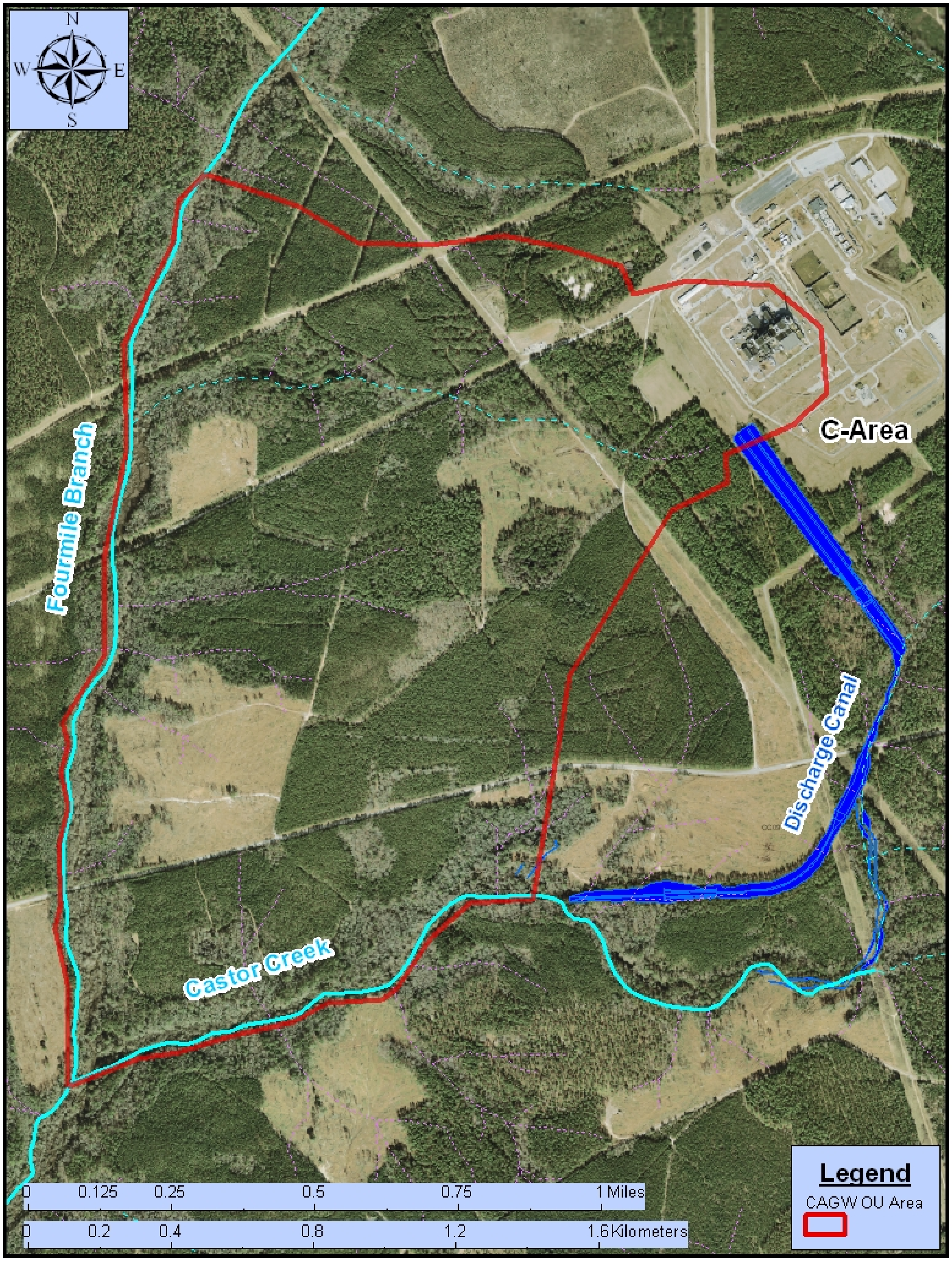


**Figure C-2. CAGW OU 2015 Boundary Area and Plumes**

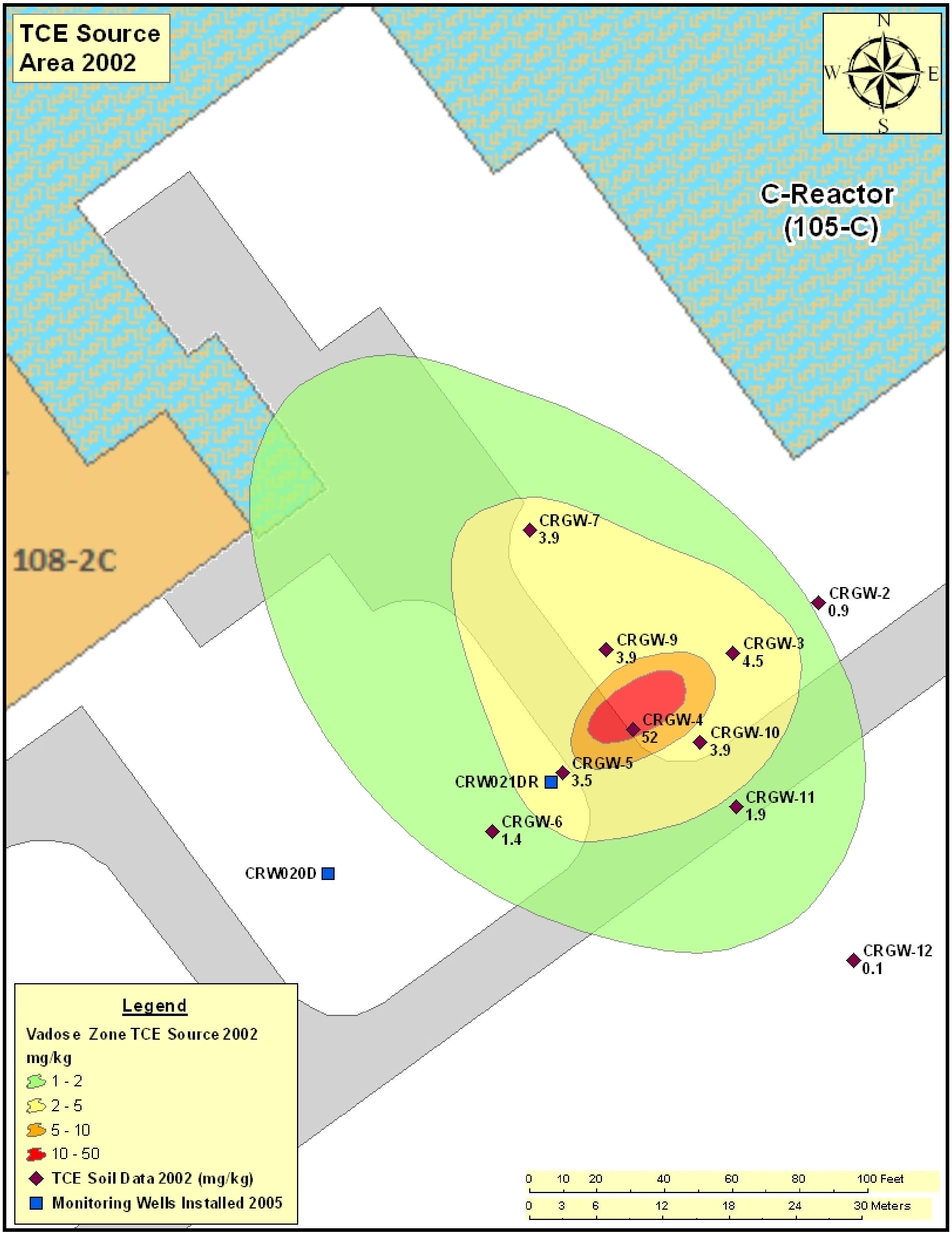


Figure C-3. CAGW OU 2002 TCE Vadose Zone Source Subunit

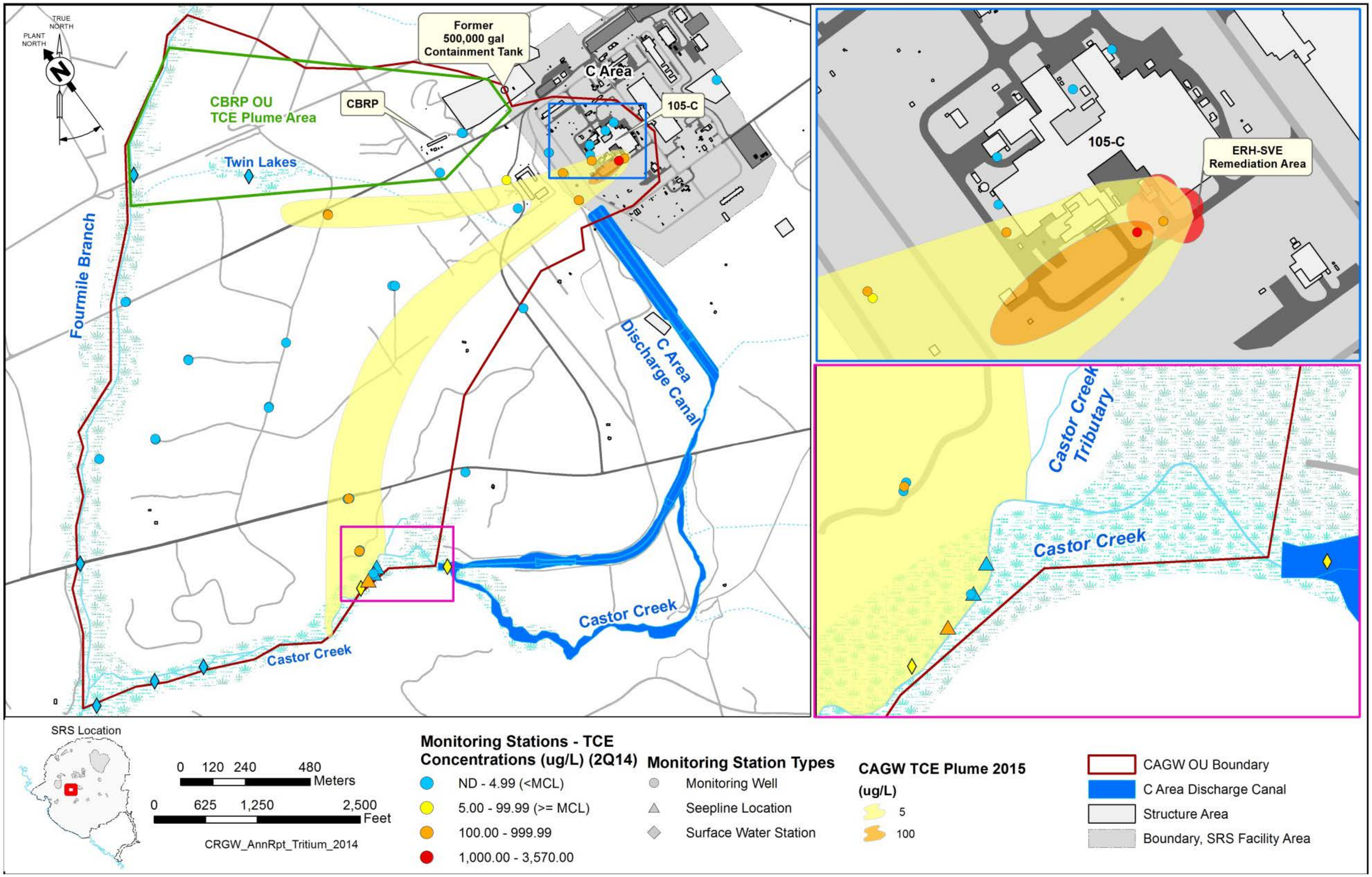


**Figure C-4. CAGW 2Q14 TCE Plume Map for Upper Three Runs Aquifer**

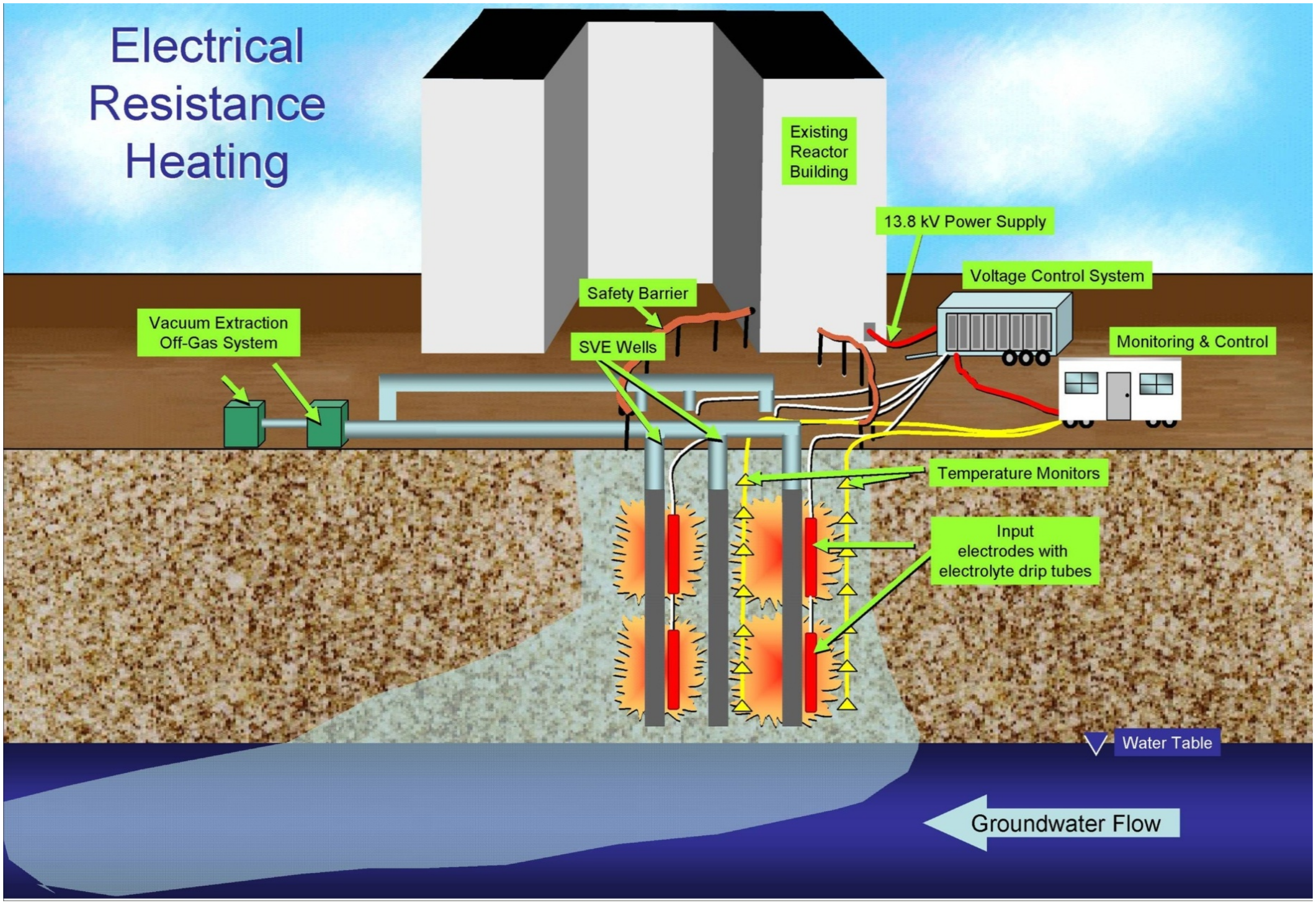


**Figure C-5. Generalized Graphic of an ERH with SVE System**

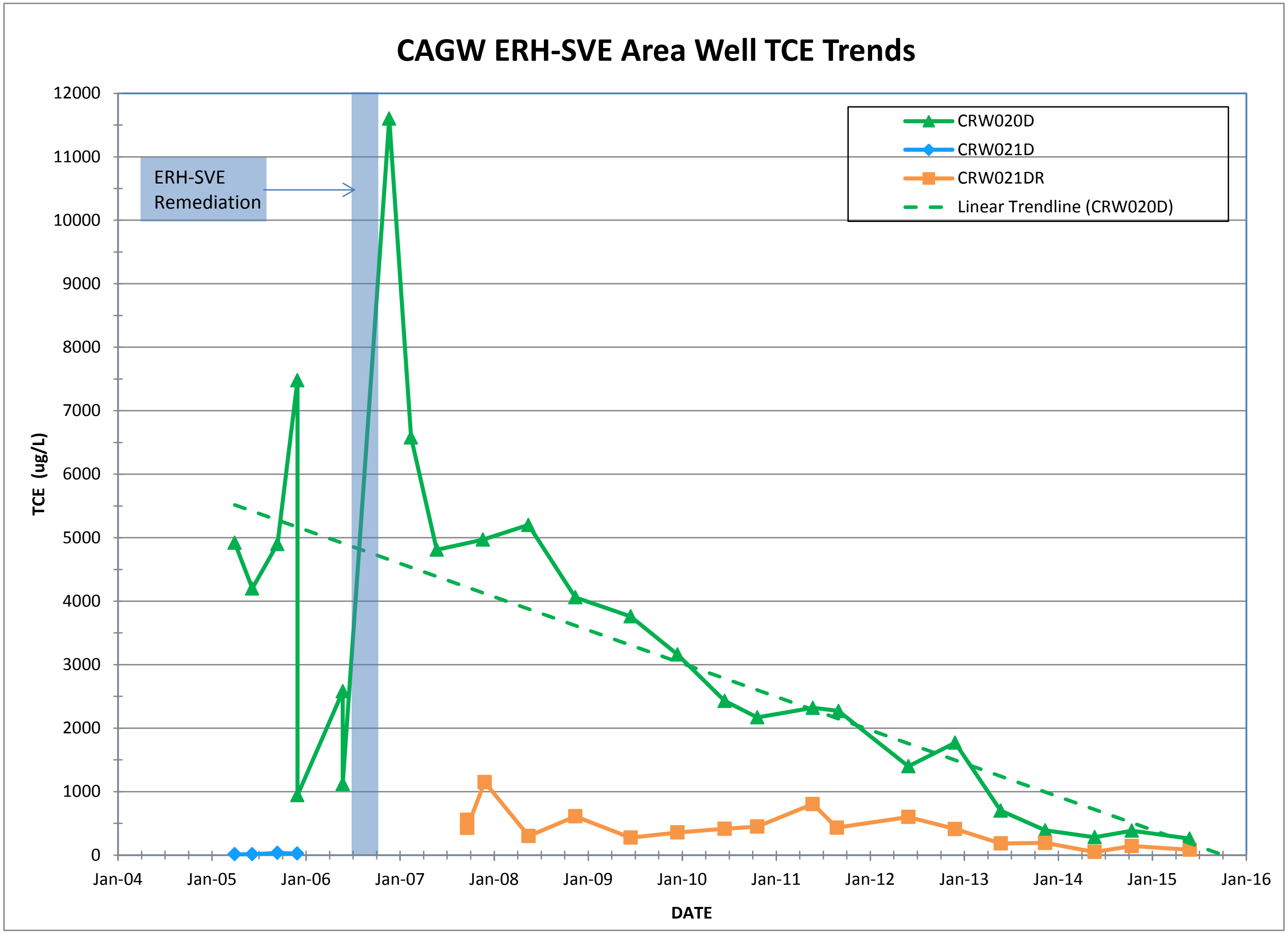


**Figure C-6. TCE Groundwater Trends at the ERH with SVE Area Wells (2005 to 2015)**

**Table C-1. Chronology of OU Events**

| Event | Date |
|---|---|
| RFI/RI Field Start | February 20, 2002 |
| Interim Record of Decision (ROD) Issuance | October 15, 2004 |
| Interim Remedial Action Construction Start / Completion | July 13, 2005 / June 15, 2006 |
| Interim Remedial Action Operations Start / Completion | June 15, 2006 / September 28, 2006 |
| FFA Scheduled Final ROD Issue Date | March 2020 |
| Previous Five-Year Reviews Issuance | January 28, 2009 / February 4, 2014 |

**Table C-2. Summary of Constituents of Concern and Remedial Goals for CAGW OU**

| Medium of Concern | Constituents of Concern | Remedial Goal (MCL) |
|---|---|---|
| Groundwater | Trichloroethylene | 5 µg/L |
| | Tetrachloroethylene* | 5 µg/L |
| | Tritium* | 20 ρCi/mL |
| Surface Water in Castor Creek | Tritium* | 20 ρCi/mL |

* The IROD only addressed trichloroethylene.

**Table C-3. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs ($) | 6,152 | 9,872 | 4,698 | 15,411 | 36,133 |
| Total IROD Estimated Direct O&M Costs ($) | 94,000[1] | 80,000 | 0 | 0 | 174,000 |

[1]FY2012 estimated costs include costs associated with the fourth five-year remedy review.

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## Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit

| **I. SITE INFORMATION** | | | |
|---|---|---|---|
| **Site Name:** | **C-Area Groundwater Operable Unit** | **Date of Inspection:** | **07/12/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS #31** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **91°F and clear** |

**Remedy Includes:** *(Click all that apply)*

- ☐ Landfill Cover/Containment
- ☐ Access Controls
- ☐ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☐ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☒ Other ERH with SVE for vadose zone remediation of VOCs, periodic groundwater monitoring. Please note that access controls and institutional controls are not a component of the interim remedy.

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

**II. INTERVIEWS** *(Click all that apply)*

**1. O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 7/15/2015 (Date)

**Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

**Problems/Suggestions:** ☐ Report Attached

**2. O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 07/15/2015 (Date)

**Interviewed:** ☒ At Site ☐ At Office ☐ By Phone Phone No.: 803-952-4416

**Problems/Suggestions:** ☐ Report Attached

**Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued)***

**II. INTERVIEWS *(Click all that apply) (Continued)***

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ______________________

**Contact:** ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________

______________________

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Monitoring wells are inspected per ER-SOP-011, “Area Completion Projects Monitoring Well Inspection (U)”

**Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued)***

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Continued)*

**1. Health and Safety Plans (HASPs):**

| | | | |
|---|---|---|---|
| ☐ Site-Specific Health and Safety Plans | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Contingency Plan/Emergency Response Plan | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER

**2. O&M and OSHA Training Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

**3. Permits and Service Agreements:**

| | | | |
|---|---|---|---|
| ☐ Air Discharge Permit | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Effluent Discharge | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Waste Disposal; POTW | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Other Permits | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**4. Gas Generation Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**5. Settlement Monument Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**6. Groundwater Monitoring Records:** ☒ Readily Available ☒ Up to Date ☒ N/A

Remarks:

**7. Leachate Extraction Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**8. Discharge Compliance Records:**

| | | | |
|---|---|---|---|
| ☐ Air | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Water (Effluent) | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**9. Daily Access/Security Logs:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

**Total annual cost by year for review period, if available**

| From: (Date) | To: (Date) | (Total Cost) | |
|---|---|---|---|
| From:______ (Date) | To:______ (Date) | ______ (Total Cost) | ☐ Breakdown attached |
| From:______ (Date) | To:______ (Date) | ______ (Total Cost) | ☐ Breakdown attached |
| From:______ (Date) | To:______ (Date) | ______ (Total Cost) | ☐ Breakdown attached |
| From:______ (Date) | To:______ (Date) | ______ (Total Cost) | ☐ Breakdown attached |
| From:______ (Date) | To:______ (Date) | ______ (Total Cost) | ☐ Breakdown attached |

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☐ Applicable ☒ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks:

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☒ N/A
Remarks:

**Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS** *(Continued)*

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walk-throughs
Frequency: Annual
Responsible Party/Agent: USDOE Savannah River Field Office

| Contact: | Karen Adams | Federal Project Director | 11/3/15 | 803-952-7871 |
|---|---|---|---|---|
| | (Name) | (Title) | (Date) | (Phone No.) |

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

Access is restricted by physical access controls to SRS (fences, guards, security patrols, etc.) and use controls are managed through the SRS Site Use/Site Clearance Program.

**2. Adequacy:** ☐ ICs are adequate ☐ ICs are inadequate ☒ N/A
Remarks:

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued)***

**VI. GENERAL SITE CONDITIONS**

**A. Roads** ☒ Applicable ☐ N/A

**1. Roads damaged:** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks:______________________________

**B. Other Site Conditions**

Remarks: ______________________________

**VII. LANDFILL COVER/CONTAINMENT** ☐ Applicable ☒ N/A

**VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A

**IX. GROUNDWATER/SURFACE WATER REMEDIES** ☐ Applicable ☒ N/A

**X. OTHER REMEDIES**

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

**A. Electrical Resistance Heating with Soil Vapor Extraction System** ☒ Applicable ☐ N/A

**1. Blowers, Wellhead Plumbing, and Electrical:**

☐ Good Condition ☐ All required wells located ☐ Needs maintenance ☒ N/A

Remarks: ERH with SVE operations are now complete. The effectiveness of the treatment is being evaluated by groundwater monitoring.

**2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:**

☐ Good Condition ☐ Needs maintenance ☒ N/A

Remarks:______________________________

**3. Spare Parts and Equipment:**

☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided

Remarks:______________________________

**4. Monitoring Wells (ERH with SVE):**

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition

☒ All required wells located ☐ Needs maintenance ☐ N/A

Remarks: The effectiveness of the treatment is being evaluated by sampling monitoring wells, CRW-1, CRW-20 and CRW-21DR.

## Attachment C-1. Five-Year Review Site Inspection Checklist – C-Area Groundwater Operable Unit *(continued/end)*

### XI. OVERALL OBSERVATIONS

**A. Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

Groundwater monitoring indicates the interim remedial action of ERH with SVE was successful in preventing further groundwater impact. Until the final CAGW OU ROD is issued, the exposure pathways that could lead to unacceptable risk are being restricted through the SRS Site Use/Site Clearance Program and monitored by periodic groundwater sampling.

**B. Adequacy of O&M**

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The protectiveness of the completed interim action of ERH with SVE is being monitored by continued groundwater sampling. The O&M procedures are effectively maintaining the monitoring wells. The wells are properly secured/locked, functioning and are in good condition. Unauthorized access to the CAGW OU is restricted by physical access controls to SRS (fences, guards, security patrols, etc.), administrative controls (SRS is a secured government facility with land use restrictions), and use controls (SRS Site Use/Site Clearance Program).

**C. Early Indicators of Potential Remedy Failure**

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

**D. Opportunities for Optimization**

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

***End of Checklist***

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# CHEMICALS, METALS, AND PESTICIDES PITS (080-170G, -171G, -180G, -181G, -182G, -183G, AND -190G) (CMP PITS) OPERABLE UNIT

## I. Introduction

This report is the fourth five-year review for the Chemicals, Metals, and Pesticides Pits (CMP Pits) Operable Unit (OU). Contaminants have been left in place at the CMP Pits OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the CMP Pits OU is protective of human health and the environment. The review was conducted from August 2015 through November 2015. This report documents the results of the review.

## II. OU Chronology

Table D-1 lists the chronology of site events for the CMP Pits OU.

## III. Background

The CMP Pits OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) (FFA 1993) for the Savannah River Site (SRS). The media of concern is surface soil, subsurface soil, groundwater, sediment, and surface water.

### Physical Characteristics

The CMP Pits OU is located in the central portion of the SRS in Barnwell County more than 11.2 km (7 mi) from the site boundary and is approximately 1,560 m (5,200 ft) north of the L-Area perimeter fence (Figure D-1). The CMP Pits are located within the Pen Branch watershed approximately 375 m (1,250 ft) southeast of Pen Branch. The OU consists of five subunits: the ballast area soils, CMP Pits and associated vadose zone (Field A), vadose zone (Field B), groundwater, and Pen Branch surface water and sediment (Figure D-2). Characteristics of each subunit are described below:

- The CMP Pits and associated vadose zone (Field A) – An approximately 0.41 hectare (1 acre) area which includes the seven former unlined pits. The seven pits are located in two rows and occupy 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. The pits occupy the top of a knoll at an approximate elevation of 94.5 m (310 ft) mean sea level (msl). Field A is the vadose zone area that was contaminated by the CMP Pits operation.
- Vadose zone (Field B) – An area approximately 0.4 hectare (one acre) that is located 30 m (100 ft) north of Field A. Field B is another vadose zone area that was contaminated by the CMP Pits operation.
- Ballast Area – An area approximately 0.2 hectare (one-half acre) that is located adjacent to and part of Field A. The Ballast Area was used to stockpile excavated pit soils and fluorescent lighting ballasts during the 1984 excavation.
- Groundwater – Previous wastes dumped at the CMP Pits has contaminated the groundwater at and near the CMP Pits with volatile organic compounds (VOCs) (primarily tetrachloroethylene [PCE] and trichloroethylene [TCE]) and the pesticide, Lindane, above maximum contaminant levels (MCLs). The groundwater plume extends from the CMP Pits northward towards Pen Branch.
- Pen Branch Surface Water and Sediment – Groundwater from CMP Pits flows towards and discharges to Pen Branch; however, the stream has never seen contaminant concentrations above MCLs. The sediment at Pen Branch has not been impacted by the CMP Pits operations.

**Land and Resource Use**

The CMP Pits OU is located in the unrestricted land use zone of SRS, outside of the industrial zone defined by the *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999a). According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. Therefore, future land use for the CMP Pits OU is reasonably anticipated to be industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

**History of Contamination**

The CMP pits were designed to receive nonradioactive wastes (chemicals, metals, and pesticides) and operated from August 1971 until February 1979. During that time, chemicals, metals, pesticides, and fluorescent lighting ballasts containing polychlorinated biphenyls (PCBs) were disposed of in the pits. In 1984, the buried wastes and surrounding soil was excavated.

PCBs and pesticides were detected in soil at or near the ground surface to the west of the CMP Pits in an area that is now referred to as the “Ballast Area”. The presence of the PCB- and pesticide-contaminated soil is attributed to stockpiling material recovered from the pits during the 1984 removal action.

However, not all contaminated soils were removed during the 1984 removal action, and the vadose zone remained contaminated with VOCs. Groundwater contamination occurred as a result of the contaminants leaching from soil. Two groundwater plumes, designated as the main plume and the northeast distal plume, exist at the CMP Pits. These plumes are moving northward towards Pen Branch. Groundwater modeling indicates that the CMP Pits are the source for the main plume (WSRC 2002). Particle tracking towards and from the northeast plume suggests that this plume is from a different source than that of the main plume. A possible source area is a drainage ditch located approximately 110 m (361 ft) north of the CMP Pits (Figure D-2). However, additional characterization efforts concluded that if a source was once present, it is now depleted (WSRC 2003a). It is also possible that the distal plume originated from the main plume, but has been separated due to the drop in the water table elevation over time, which has created a dry zone in the upper aquifer zones (Figure D-3).

No contaminants were found at levels that posed a risk to human health or the environment in the Pen Branch surface water or sediment (WSRC 2003a).

Figures D-4 and D-5 presents photographs of the CMP Pits OU before remediation and currently (2014), respectively.

**Initial Response**

The following pre-Record of Decision (ROD) activities were performed to support the overall cleanup strategy for the CMP Pits OU:

- Original excavation of the CMP Pits conducted with clean backfill and cover system (1984)
- Soil Vapor Extraction (SVE) units installed in CMP Pits Field A (Interim Action) (2001) (WSRC 1999b); however, possible dense non-aqueous phase liquid (DNAPL) was found and unexpected conditions forced additional characterization before SVE startup
- Ballast Area Soil Excavation / Off-site Incineration (Interim Action) (2000) (WSRC 1999b), however, soil containing Silvex was found that could not be treated or disposed of offsite. The amount of contaminated soil was found to be significantly greater than originally estimated. An evaluation of treatment technologies for bioremediation of Silvex contaminated soils was needed
- SVE in CMP Pits Field B (Interim Action) (2001) (WSRC 2001)
- Ballast Area Soil Excavation / Bioremediation (Treatability Study – Phase I) (2001)
- SVE in CMP Pits Field A (Interim Action) (2002) (WSRC 2001)
- SVE units converted to passive system (BaroBalls™) in Field B (Interim Action) (2002) (WSRC 2001)
- Ballast Area Soil Excavation / Bioremediation (Treatability Study – Phase II) (2002) (WSRC 2003c)

- Ballast Area Soil Excavation / Bioremediation (Interim Action) (2004) (WSRC 2003b).

DNAPL VOC contamination was found to be trapped in the clay horizon beneath the CMP Pits in Field A, where SVE units alone could not remediate the contamination. Additional remediation techniques were needed to remediate the contaminant source to groundwater.

**Basis for Taking Action**

Releases of VOCs (predominantly PCE and TCE) and pesticides to groundwater have occurred from contaminated soil at the CMP Pits. Groundwater is contaminated above MCLs with PCE, TCE, Lindane, and carbon tetrachloride. Exposure to these constituents above MCLs through ingestion or prolonged dermal contact increases the risk of cancer. The refined constituents of concern (RCOCs) for the CMP Pits OU are listed in Table D-2.

The CMP Pits OU remedial goals (RGs) were developed to be protective in soil based upon future industrial land use and in groundwater to achieve MCLs or residential RGs (Table D-2).

## IV. Remedial Actions

**Remedy Selection**

In 2005, a final ROD (WSRC 2004) was issued to address the source of contamination in the vadose zone and the groundwater plume. The selected remedy for the Ballast Area is LUCs to prevent direct contact to PCB-contaminated soils above concentrations of 1 mg/kg. The selected remedy for the CMP Pits and associated vadose zone is a combination of ERH to remove DNAPL from the vadose zone and continued operation of the SVE system in Field A. Continued operation of the passive SVE system via BaroBalls™ was selected for Field B. As stated in the ROD, the remedial action objectives (RAOs) are as follows:

***Ballast Area***

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

- Prevent direct contact with pesticide-contaminated surface soils so that constituents of concern (COCs) do not present an unacceptable risk to human and ecological receptors.

***CMP Pits Field A and B Vadose Zone***

- Prevent COC migration to groundwater, and

- 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, and

- Prevent discharge of contaminated groundwater to surface water at concentrations above MCLs.

***Surface Water and Sediment***

No remedial action objectives were established for the Pen Branch surface water and sediment because no COCs were identified.

**Remedy Implementation**

The implementation of the final remedial action included the following activities:

***Ballast Area***

- Established land use controls (LUCs) (i.e., physical access controls to prevent unauthorized entry to SRS [fences, guards, security patrols, etc.], administrative controls that maintain the CMP Pits OU for industrial use only, warning signs, and use restrictions via the SRS Site Use/Site Clearance Program) after the completion of the interim action. The interim action included a small portion of contaminated soil that was removed for incineration at an offsite facility. The remaining Silvex contaminated soil was treated onsite using enhanced bioremediation.

***CMP Pits Field A Vadose Zone***

- Operated electrical resistance heating (ERH) to remove DNAPL and continued operation of the SVE system throughout the ERH operation.

***CMP Pits Field B Vadose Zone***

- Continued operation of the interim action passive SVE system via BaroBalls™.

***Groundwater***

- Established a monitored natural attenuation (MNA) network by installing additional groundwater monitoring wells. MNA will effectively remediate the low-concentration residual groundwater contamination that remains following completion of the source control remedial action. The PCE plumes comprised approximately 17.8 hectares (44 acres); the TCE plumes comprised approximately 16.6 hectares (41 acres) in 2011,

- Issued an Effectiveness Monitoring Plan (EMP), which provides the sampling and reporting requirements associated with MNA (WSRC 2006a).

- Established LUCs for 2.9 hectares (7.1 acres) at the CMP Pits OU (Figure D-2).

**System Operations/Operation and Maintenance**

Operations at the CMP Pits OU are now complete.

- ERH and SVE have been completed in Field A. The ERH equipment and associated SVE wells were removed or abandoned in accordance with SRS Manual 3Q5 (i.e., currently SRS Manual 3Q1) and R.61-71 South Carolina Well Standards. The results of the ERH/SVE operations were reported in the 2009 Effectiveness Monitoring Report (EMR) (SRNS 2009). Confirmation soil sampling was reported in the 2010 EMR (SRNS 2010).

- At Field B, the passive SVE units were abandoned concurrently with the Field A SVE abandonments.

The following maintenance activities are ongoing:

- Groundwater and surface water monitoring for the MNA network. Sampling will continue until MCLs have been attained. The MNA remedy will be evaluated annually in EMRs based on groundwater monitoring data as defined in the approved EMP (WSRC 2006a). Groundwater monitoring data has been reported in EMRs since June 2009. Based on modeling projections (WSRC 2002), the MNA remedy is expected to reduce groundwater concentrations to below MCLs in as soon as 40 years (approximately 2055).
- Annual site inspections for evidence of damage to the cover system due to erosion or intrusion by burrowing animals. The inspections also address upkeep of the vegetative cover and access control barriers (e.g., the warning signs).
- Necessary repairs (e.g., replacing eroded or disturbed soil, sign repair, etc.) and vegetation management (e.g., mowing, removal of larger vegetation, etc.) are being performed when required.
- LUCs (i.e., physical access controls to prevent unauthorized entry to SRS [fences, guards, security patrols, etc.], administrative controls that maintain the CMP Pits OU for industrial use only, and warning signs) are being enforced to preclude access through the SRS Site Use/Site Clearance program and SRS site security.

The operation and maintenance (O&M) costs associated with the selected remedy for CMP Pits OU includes maintenance of the soil cover, groundwater monitoring and LUCs (WSRC 2004). The estimated O&M cost from the ROD since the last remedy review for these activities is $160,896 for FY2012 through FY2015. The actual (O&M) cost for FY2012 until FY2015 is $725,214. The actual O&M costs (Table D-3) were higher than expected because the current number of monitoring wells and surface water sampling locations (76) is much larger than the ROD estimate (12), maintenance activities were required, as well as additional work was conducted in FY2015 based on regulatory input. Based on inspections conducted from FY2012 through FY2015, various maintenance activities completed at CMP Pits included vegetation cutting and clearing drainage ditches, vegetation cutting on soil cover, treating active ant mounds, vegetation removal from around drainage pipe, and repairing damage the soil cover due to hog rooting.

## V. Progress Since Last Review

The previous protectiveness statement concluded that the remedial actions at CMP Pits OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks have been controlled by the operation of ERH/SVE and passive SVE and are currently being controlled with MNA and institutional controls that have been functioning properly.

The ERH and/or SVE systems were effective at removing VOC contamination from the vadose zone created when the water table level dropped in elevation in Field B and from the porous horizons in the source area in Field A. The source term has been depleted; therefore, the ERH and SVE systems were shut down and abandoned. Groundwater and surface water monitoring per the EMP has been ongoing since 2007. These results have been documented in annual EMRs (SRNS 2009; SRNS 2010; SRNS 2011; SRNS 2012; SRNS 2013; SRNS 2014a; SRNS 2015a). Additional groundwater characterization data collected in 2015 was documented in a stand-alone submittal (SRNS 2015c).

Analysis of 1,4-dioxane in the groundwater and surface water at the CMP Pits OU was recommended during the Fourth Five-Year Remedy Review (SRNS 2014b). During 2013 and 2014, 1,4-dioxane was sampled annually. It was detected in approximately 38% of the monitoring wells with a maximum value of 200 µg/L. In general, 1,4-dioxane is detected around the CMP Pits source area and in the wetland area wells near Pen Branch, but is minimally detected at intermediate wells. 1,4-Dioxane was detected in surface water during 2013 with a maximum value of 3.93 µg/L; however, it was not detected during 2014. As discussed in the CMP Pits EMRs, 1,4-dioxane will continue to be monitored with annual sampling.

Additionally, due to concerns expressed by the USEPA, groundwater throughout the Upper Three Runs Aquifer was investigated north of Pen Branch in 2015 to determine if the VOC contaminant plumes had migrated underneath the stream (SRNS 2015b, SRNS 2015c). Additional samples were also collected south of Pen Branch to fill data gaps. Furthermore, an updated groundwater model is planned to be conducted in 2017 to reevaluate the hydrogeologic conditions and contaminant plumes.

## VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed,
- Confirmed implementation of the remedial action,
- Reviewed all process and performance monitoring data provided by the annual EMRs and provided a technical assessment of whether the ERH/SVE and passive SVE functioned as intended by the ROD and whether the shutdown criteria has been achieved,
- Reviewed the groundwater and surface water monitoring data provided in the EMRs (SRNS 2009; SRNS 2010; SRNS 2011; SRNS 2012; SRNS 2013; SRNS 2014a; SRNS 2015a) as summarized in Table D-4,
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment D-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls, and
- Reviewed changes in standards and to-be-considered guidance.

### Data Review

Seven annual EMRs submitted to date were reviewed (2009 [SRNS 2009]; 2010 [SRNS 2010]; 2011 [SRNS 2011]; 2012 [SRNS 2012]; 2013 [SRNS 2013]; 2014 [SRNS 2014a]; 2015 [SRNS 2015a]). These reports include all sample results for PCE, TCE, carbon tetrachloride, associated VOC degradation products, 1,4-dioxane, and Lindane collected from monitoring wells and surface water stations between 2008 and 2014. These reports include time-series plots at each monitoring station for PCE, TCE, 1,4-dioxane and Lindane since 2001, plume maps for the four main constituents (i.e., PCE, TCE, Lindane, and 1,4-dioxane), and cross-sections of the stratigraphy with the PCE, 1,4-dioxane, and Lindane plumes.

Additional characterization sampling that investigated groundwater north of Pen Branch as well as locations south of Pen Branch to fill data gaps was conducted in the first half of 2015 under the approved Sampling and Analysis Plan (SRNS 2015b) (Figure D-6). A sampling results summary was submitted to USEPA and SCDHEC in August 2015 (SRNS 2015c). The summary report concluded that contamination had not migrated underneath Pen Branch. Additionally, the data collected on the south side of Pen Branch showed contamination was limited to the upper portion of the lower aquifer zone of the Upper Three Runs Aquifer as expected. Lindane was not detected in any samples confirming the Lindane plume remains near the source area.

**Summary of Inspections and Interviews**

Interviews were conducted with Richard Feagin, O&M staff member, on July 15, 2015 by phone and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The CMP Pits OU was inspected by Savannah River Nuclear Solutions, LLC (SRNS) and USDOE personnel on July 21, 2015 and November 2, 2015, respectively. No issues were identified for the CMP Pits OU during the inspections and interviews.

## VII. Technical Assessment

**Is the Remedy Functioning as Intended by the Decision Document?**

The remedy is functioning as intended as demonstrated below:

- Soil treatment via enhanced bioremediation was effective in preventing exposure to human and ecological receptors with PCB-contaminated surface soils at the Ballast Area. Monitoring and sampling data verified that the RGs were achieved as shown in

Table D-5. Further information on the enhanced bioremediation can be found in the Interim Post-Construction Report (WSRC 2006b).

- The ERH/SVE and passive SVE were effective in preventing RCOC migration to groundwater. As reported in the 2010 EMR (SRNS 2010), concentrations of VOC contamination in the vadose zone soils were greatly reduced to levels below RGs. Pre-ERH/SVE concentrations of PCE were as high as 8,800 mg/kg. After the ERH/SVE shutdown, 59 confirmation soil samples were collected. The maximum PCE result was 1.8 mg/kg, well below the RG of 30.7 mg/kg. Confirmation dichloromethane (DCM) soil sample results were at a maximum of 0.0111 mg/kg, well below the RG of 0.2 mg/kg.

- Groundwater results around the actual CMP Pits source area have been decreasing with time and were at a maximum PCE concentration of 680 µg/L in 2014 (Table D-4). DCM groundwater results have been below the MCL (5 µg/L) since the ERH/SVE shutdown. The 2014 DCM maximum result was 1.4 µg/L. Table D-4 compares the Pre-ERH/SVE groundwater concentrations with current (2014) concentrations.

- Lindane contamination in groundwater continues to stay near the source area and has not impacted the Pen Branch stream. A few wells have increased in concentration; however, many of the wells have decreased in concentration. The number of wells exceeding the Lindane MCL has decreased from seven monitoring wells in 2008 to four monitoring wells in 2014.

- The Field A cover system is effective in preventing residential exposure to surface soils above RGs. The cover system maintenance program and LUCs have been effective in maintaining the integrity of the cover system. The annual inspection reports indicate no significant deficiencies.

- The MNA and LUCs are effective in preventing human exposure to contaminated groundwater. Overall, RCOC concentrations have been reduced in the groundwater.

- The MNA is effective in preventing discharge of contaminated groundwater to surface water. RCOC concentrations of surface water have always been below MCLs. Results are mainly non-detect.

- Although not widespread throughout CMP Pits, biological processes in the wetland area near Pen Branch are degrading VOCs to degradation products. Cis-1,2-dichloroethylene was detected in 2014 in groundwater at a maximum of 11.5 µg/L, which is below the 70 µg/L MCL. It was also detected in surface water at values less than 1 µg/L. Vinyl chloride was detected once in 2014 at one well, CMP 40D, with a concentration of 5.21 µg/L, which is above the 2 µg/L MCL.

The above remedial activities are meeting the RGs established for the CMP Pits OU, as discussed in Section IV, by eliminating or controlling all routes of exposure to human health and ecological receptors.

**Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?**

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. No changes in MCLs have occurred since the last five-year remedy review in 2012 for the currently monitored RCOCs. However, the regional screening level (RSL) for 1,4-dioxane has changed from 0.67 µg/L to 0.46 µg/L. 1,4-Dioxane does not have an MCL, so the USEPA tap water RSL is used as the groundwater protection standard. Although this change did not impact the effectiveness of the remedy, future reports (starting with the 2016 EMR) will reflect this change.

Appendix B provides an evaluation of changes in standards and toxicity for chemical and radiological constituents since the last five-year remedy review was initiated in 2012. There have been no significant changes to the 2015 preliminary remedial goal (PRG) and regional screening level (RSL) values that would impact the protectiveness of the remedy. Soil treatment is effective in reducing the concentration of contaminants and exposure to human and ecological receptors at the Ballast Area. The Field A cover system prevents exposure of human and ecological receptors to remaining soil contaminants left in place. In addition, more stringent PRGs/RSLs would not impact the LUCs that are in place to prevent exposure to or ingestion of contaminated groundwater or soil media at the CMP Pits OU.

There have been no changes in standards or physical conditions of the CMP Pits OU that would affect the protectiveness of the remedy.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No new information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

No issues have been identified for the CMP Pits OU.

## IX. Recommendations and Follow-up Actions

No recommendations and follow-up actions have been determined for the CMP Pits OU.

## X. Protectiveness Statement(s)

The remedy at the CMP Pits OU is protective of human health and the environment in the short-term.

Currently, exposure pathways that could result in unacceptable risks are being controlled by LUCs to prevent exposure to, or the ingestion of, contaminated soil and groundwater. All threats to contaminated soil at the CMP Pits OU have been addressed through implementation of the soil cover, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the CMP Pits OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program. However, in order to establish long-term protectiveness, additional remedial actions may need to be evaluated and selected, as necessary, based on results of groundwater modeling and continued groundwater and surface water monitoring.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2009. *Effectiveness Monitoring Report for the Electrical Resistance Heating (ERH)/ Soil Vapor Extraction (SVE) and Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2008 through March 2009*, SRNS-RP-2009-00573, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010. *Effectiveness Monitoring Report for the Electrical Resistance Heating (ERH)/ Soil Vapor Extraction (SVE) and Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2009 through March 2010*, SRNS-RP-2010-00896, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2011. *Effectiveness Monitoring Report for the Monitored Natural Attenuation at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2010 through March 2011*, SRNS-RP-2011-01136, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2011 through March 2012*, SRNS-RP-2012-00158, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2013. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U)*

*March 2012 through March 2013*, SRNS-RP-2013-00121, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014a. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2013 through March 2014*, SRNS-RP-2014-00345, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014b. *Fourth Five-Year Remedy Review Report for the Savannah River Site Aiken, South Carolina*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015a. *Effectiveness Monitoring Report for the Monitored Natural Attenuation (MNA) at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U) March 2014 through March 2015*, SRNS-RP-2015-00252, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015b. *Sampling and Analysis Plan for the Chemicals, Metals, and Pesticide (CMP) Pits Operable Unit (O)(U)*, SRNS-RP-2014-01203, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015c, *Additional Characterization Sampling Results Summary at the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit (OU)(U)*, SRNS-RP-2015-00496, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999a. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest revision, Savannah River Nuclear Solutions LLC, Savannah River Site, Aiken, SC

WSRC, 1999b. *Interim Record of Decision 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-98-4198, Revision 1.1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2001. *Interim Record of Decision Amendment for the Chemicals, Metals, and Pesticides Pits (080-170G, 080-171G, 080-180G, 080-181G, 080-182G, 080-183G, 080-190G) (U)*, WSRC-RP-2000-4158, Revision 1.2, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2002. *Groundwater Modeling for the Chemical, Metals, and Pesticides (CMP) Pits (U)*, WSRC-RP-2002-4195, Revision 0, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

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

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WSRC, 2004. *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)*, WSRC-RP-2004-4090, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2006a. *Effectiveness Monitoring Plan for the Electrical Resistance Heating (ERH)/Soil Vapor Extraction (SVE) System and Monitored Natural Attenuation at the Chemicals, Metals, and Pesticides Pits Operable Unit (U)*, WSRC-RP-2005-4077, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2006b. *Interim Post-Construction Report (IPCR) for the Chemicals, Metals, and Pesticides (CMP) Pits Operable Unit – Ballast Area (080-170G, 080-171G, 080-180G,* *080-181G, 080-182G, 080-183G, 080-190G) (U)*, WSRC-RP-2005-4065, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

Various - *Inspection Data Sheets – Field Inspection Checklist Chemical, Metal, and Pesticides Pits (U)*, ER-IDS-019-062, Inspection period 2012 through 2015 (annually)

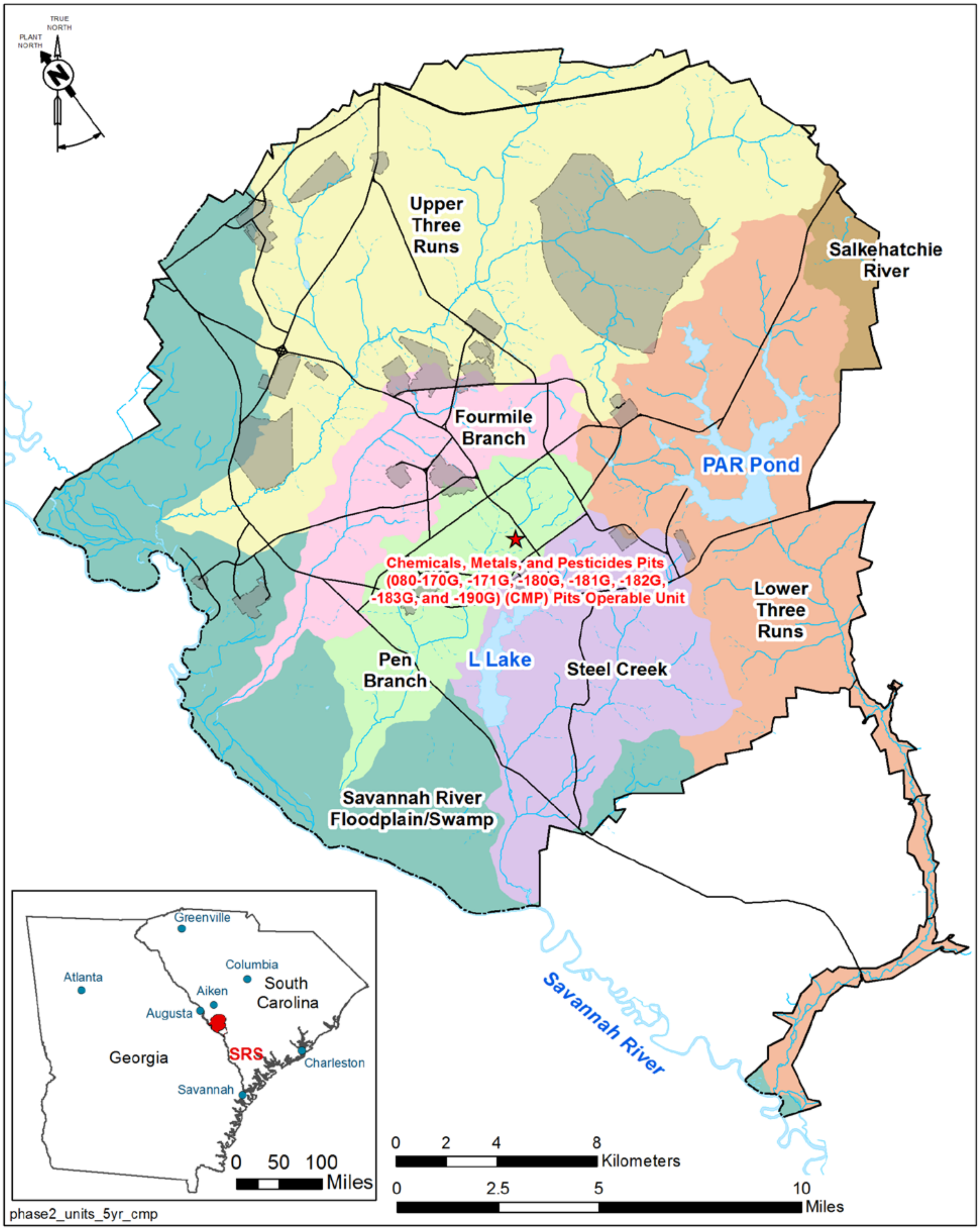


**Figure D-1. Location of the CMP Pits OU at SRS**

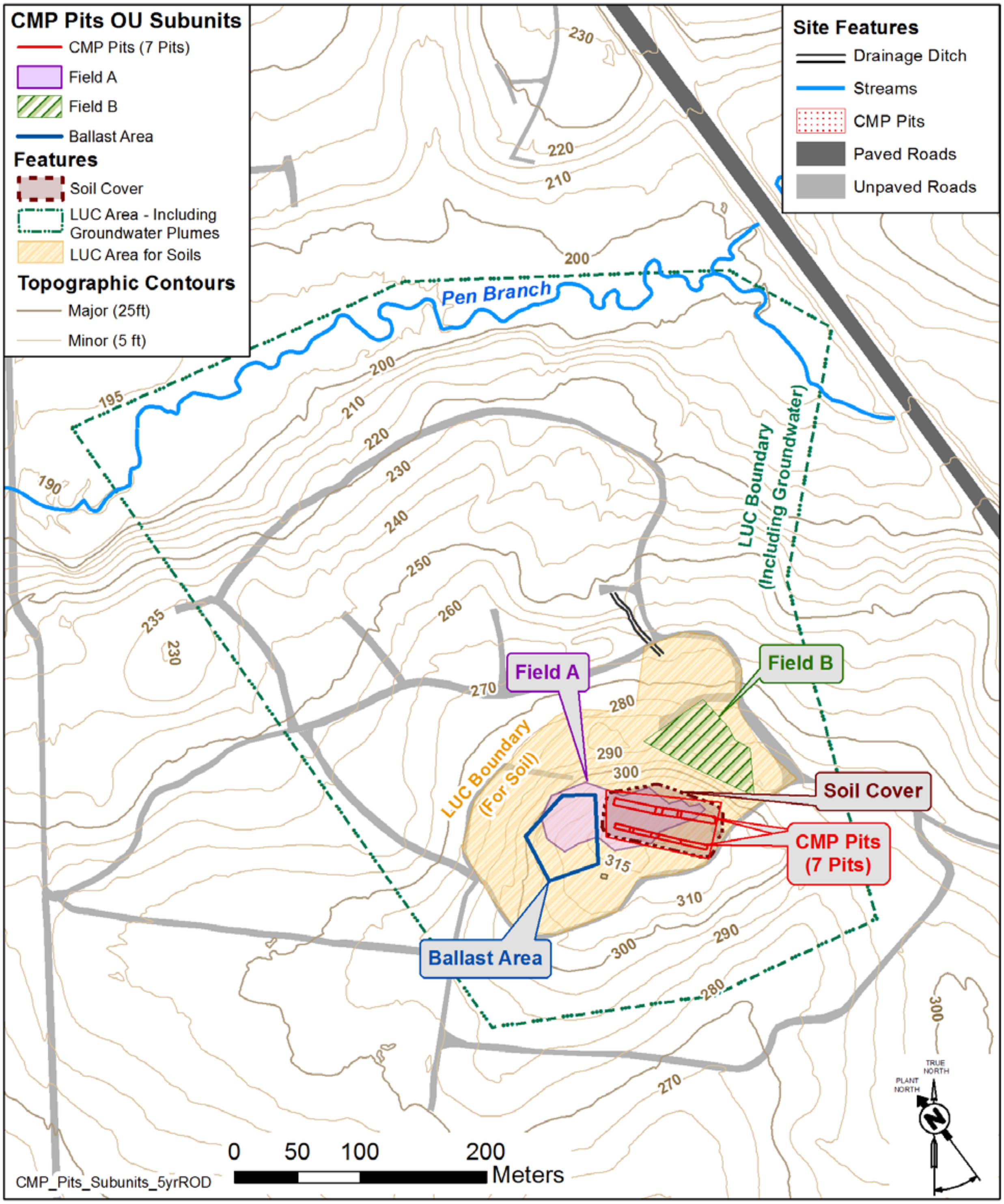


**Figure D-2. Layout of the CMP Pits OU**

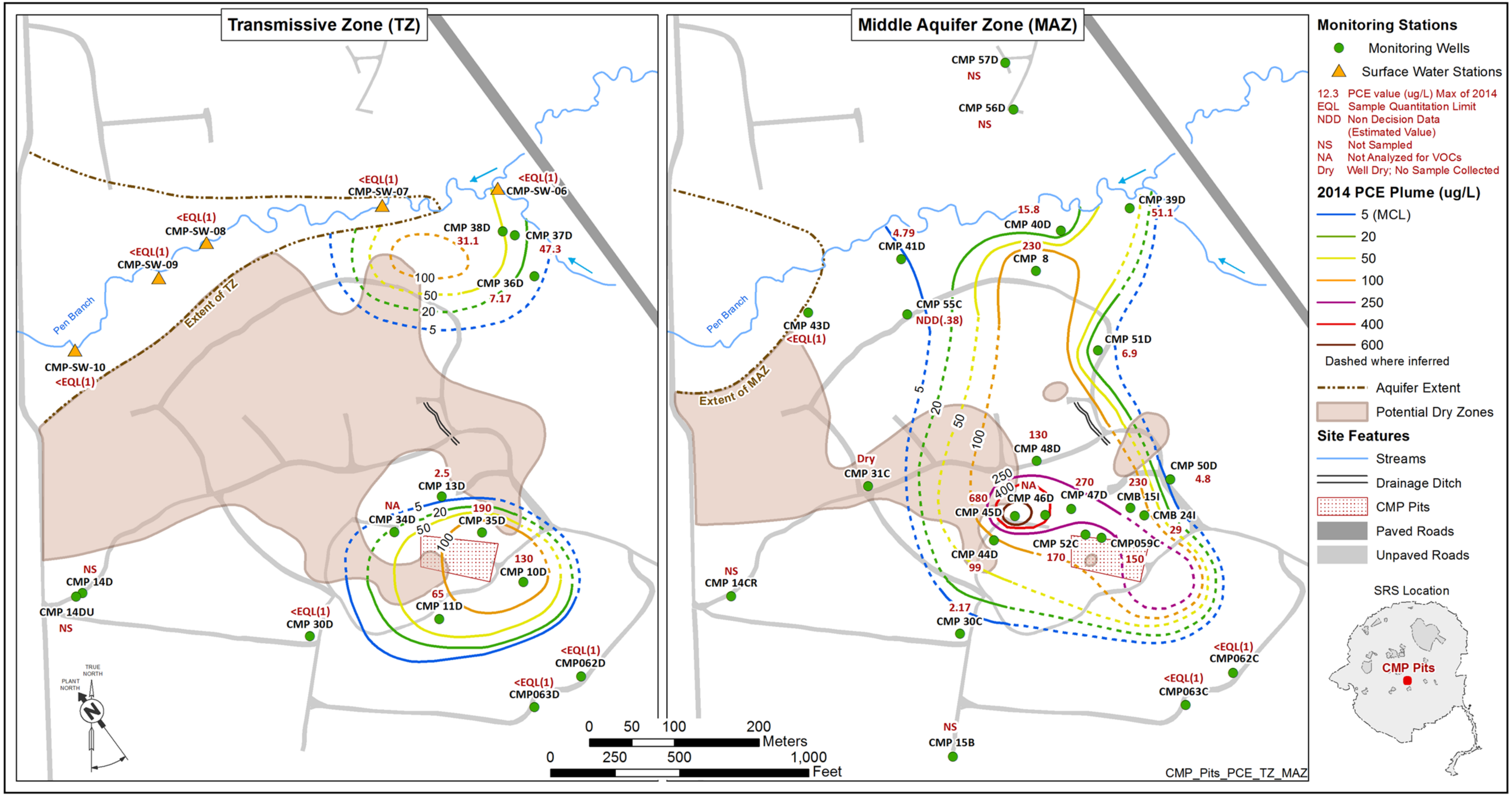


Figure D-3. 2014 PCE Plume in the Transmissive Zone and Middle Aquifer Zone

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**Figure D-4. Photo of CMP Pits before Remediation Activities (During Disposal Operation)**


**Figure D-5. Photo of CMP Pits (Current) (2015)**

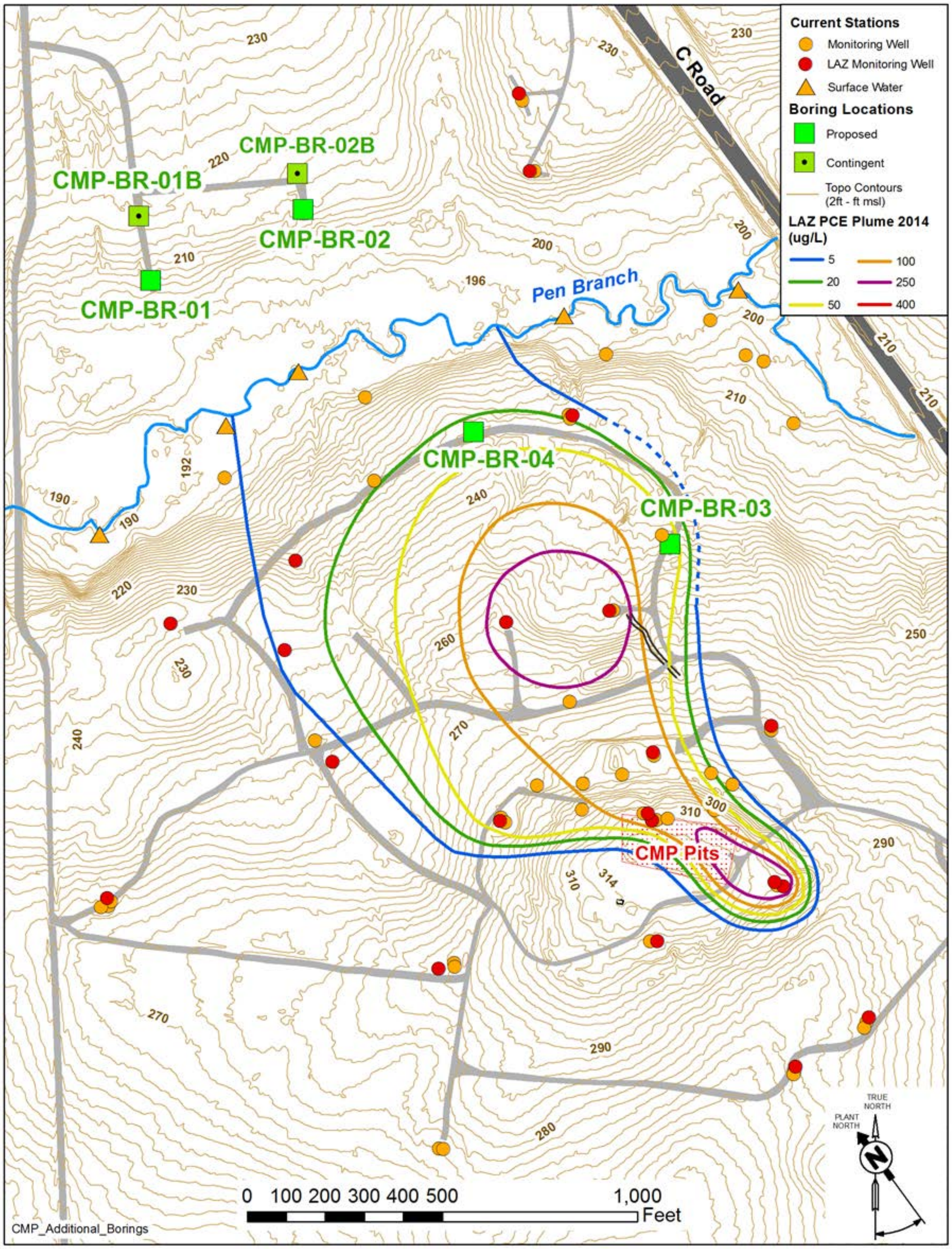


**Figure D-6. Locations of Additional Groundwater Investigations in 2015 (Lower Aquifer Zone PCE Plume)**

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**Table D-1. Chronology of OU Events**

| Event | Date |
|---|---|
| Removal Action (Soil Excavation) | 1984 |
| Remedial Investigation Complete | October 1, 1997 |
| Interim ROD Issuance | January 19, 2000 |
| Interim Remedial Action Construction Start / Completion | December 10, 1999 / December 5, 2001 |
| Interim Remedial Action Operations Start / Completion | April 23, 2001 / October 12, 2005 |
| First Interim ROD Amendment Issuance | April 8, 2002 |
| Second Interim ROD Amendment Issuance | October 21, 2003 |
| ROD Issuance | May 10, 2005 |
| Remedial Action Construction Start / Completion | April 6, 2006 / November 7, 2007 |
| Remedial Action Operations Start / Completion | November 2007 / June 28, 2009 |
| Previous Five-Year Reviews | February 12, 2004 / January 28, 2009 / February 4, 2014 |

## Table D-2. CMP Pits RCOCs by Medium and Subunit with Final Remedial Goals

| | | Type of RCOC | | | | | |
|---|---|---|---|---|---|---|---|
| **Area/Media of Concern** | **Refined COCs** | **ARAR** | **CM/ PTSM** | **HH** | **ECO** | **RGs (mg/kg or mg/L)** | **Final Remedial Goal Basis** |
| **Ballast Area** | PCB | ✓ | | | ✓ | 1.00E+00 | ARAR |
| | Dieldrin | | | ✓ | ✓ | 6.84E-02 | Ecological |
| | Endrin | | | | ✓ | 3.97E-02 | Ecological |
| | Heptachlor Epoxide | | | | ✓ | 2.10E-02 | Ecological |
| | p,p'-DDD | | | | ✓ | 2.87E-01 | Ecological |
| | p,p'-DDE | | | | ✓ | 5.54E-01 | Ecological |
| | p,p'-DDT | | | ✓ | ✓ | 1.62E+00 | Ecological |
| **CMP Pits and Associated Field A Vadose Zone [2]** | Dichloromethane | | ✓ | | | 2.48E-02 | Contaminant migration |
| | Tetrachloroethylene | | ✓ | | | 3.07E+01 | Contaminant migration |
| **Groundwater** | Alpha-benzene hexachloride | | | ✓ | | 5.33E-06 | Future Resident |
| | Beta-benzene hexachloride | | | ✓ | | 1.84E-05 | Future Resident |
| | Delta-benzene hexachloride | | | ✓ | | 1.84E-05 | Future Resident |
| | Dieldrin | | | ✓ | | 2.09E-06 | Future Resident |
| | Lindane | ✓ | | ✓ | | 2.00E-04 | ARAR |
| | Bis(2-ethylhexyl) phthalate | ✓ | | ✓ | | 6.00E-03 | ARAR |
| | Total Trihalomethanes[1] | ✓ | | ✓ | | 0.80E-01 | ARAR |
| | Carbon Tetrachloride | ✓ | | ✓ | | 5.00E-03 | ARAR |
| | Dichloromethane | ✓ | | ✓ | | 5.00E-03 | ARAR |
| | Tetrachloroethylene (PCE) | ✓ | | ✓ | | 5.00E-03 | ARAR |
| | Trichloroethylene (TCE) | ✓ | | ✓ | | 5.00E-03 | ARAR |

1. Total Trihalomethanes includes chloroform and bromodichloromethane. Although these constituents are not ARAR COCs (Site concentrations pose a risk but do not exceed the MCL), they do have an MCL that is an ARAR and; as such, is the appropriate final RG.
2. Vadose zone RGs apply anywhere in the vadose zone. The RGs 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 remedial action objective of preventing migration to groundwater.

**Table D-3. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs | $159,138 | $109,588 | $114,308 | $342,179 | $725,214 |
| Total ROD Estimated Direct O&M Costs | $50,205[1] | $36,897 | $36,897 | $36,897 | $160,896 |

[1]FY2012 estimated costs include costs associated with the fourth five-year remedy review.

**Table D-4. Comparison of RGs and Groundwater and Surface Water Monitoring Data from 2014**

| | RGs | Groundwater | | Surface Water |
|---|---|---|---|---|
| RCOC | MCL (µg/L)* | 2007 (Pre-ERH/SVE) Maximum Concentration (µg/L) | 2014 Maximum Concentration (µg/L) | 2014 Maximum Concentration (µg/L) |
| PCE | 5.0 | 1,350 | 680 | Non Detect |
| TCE | 5.0 | 851 | 315 | Non Detect |
| Lindane | 0.2 | 3.05 | 4.7 | Not Analyzed |
| Carbon Tetrachloride | 5.0 | 24.6 | 8.0 | Non Detect |
| Dichloromethane | 5.0 | 2.09 | 1.4 | Non Detect |
| Bromodichloromethane | 80 | 16 | 4.95 | Non Detect |
| Chloroform | 80 | 30.4 | 11.8 | Non Detect |

* MCL values are based on USEPA values available June 2015.

**Table D-5. Ballast Area Enhanced Bioremediation Soil Sample Confirmation Results**

| RCOC | Remedial Goal (µg/kg) | Maximum Result of Confirmation Samples (µg/kg) |
|---|---|---|
| PCB | 1,000 | 192 |
| Dieldrin | 68.4 | 40.9 |
| Endrin | 40 | 9.06 |
| Heptachlor Epoxide | 21 | 8.55 |
| p,p’-DDD | 287 | 194 |
| p,p’-DDE | 554 | 49.6 |
| p,p’-DDT | 1620 | 322 |

## Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit

**I. SITE INFORMATION**

| | | | |
|---|---|---|---|
| **Site Name:** | **Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit** | **Date of Inspection:** | **07/21/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS #24** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **91°F and clear** |

**Remedy Includes:** *(Click all that apply)*

- ☒ Landfill Cover/Containment
- ☐ Access Controls
- ☒ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☒ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☒ Other Operation and combination of Electrical Resistance Heating (ERH) and continued operation of the Soil Vapor Extraction (SVE) system (Field A); passive SVE via BaroBalls$^{TM}$ (Field B) have been concluded. MNA is continuing.

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

**II. INTERVIEWS** *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 7/15/2015 (Date)

   **Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

   **Problems/Suggestions:** ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 7/15/2015 (Date)

   **Interviewed:** ☐ At Site ☐ At Office ☒ By Phone Phone No.: 803-952-4416

   **Problems/Suggestions:** ☐ Report Attached

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

**II. INTERVIEWS** *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: See *Waste Unit Inspection and Maintenance, ER-SOP-019, Field Inspection Checklist for Chemical Metal and Pesticides Pits*, ER-IDS-019-062.

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

**III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)***

**2. Health and Safety Plans (HASPs):**

| | | | |
|---|---|---|---|
| ☐ Site-Specific Health and Safety Plans | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Contingency Plan/Emergency Response Plan | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER

**3. O&M and OSHA Training Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per EC&ACP training matrix.

**4. Permits and Service Agreements:**

| | | | |
|---|---|---|---|
| ☒ Air Discharge Permit | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Effluent Discharge | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Waste Disposal; POTW | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Other Permits | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**5. Gas Generation Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**6. Settlement Monument Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**7. Groundwater Monitoring Records:** ☒ Readily Available ☐ Up to Date ☐ N/A

Remarks: Water elevation records only.

**8. Leachate Extraction Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**9. Discharge Compliance Records:**

| | | | |
|---|---|---|---|
| ☒ Air | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Water (Effluent) | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**10. Daily Access/Security Logs:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

**Total annual cost by year for review period, if available**

| From: (Date) | To: (Date) | (Total Cost) | |
|---|---|---|---|
| | | | ☐ Breakdown attached |
| | | | ☐ Breakdown attached |
| | | | ☐ Breakdown attached |
| | | | ☐ Breakdown attached |
| | | | ☐ Breakdown attached |

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☒ Applicable ☐ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks:

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☐ N/A
Remarks: Signs at this site are in good condition.

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)***

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walk-throughs
Frequency: Annually
Responsible Party/Agent: USDOE Savannah River Field Office

| Contact: | Jasmin Selby | Project Manager | 11/2/15 | 803-952-7871 |
|---|---|---|---|---|
| | (Name) | (Title) | (Date) | (Phone No.) |

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☒ No ☐ N/A
Problems/Suggestions: ☐ Report Attached

**2. Adequacy:** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Survey monuments were located and in good condition

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

| **VI. GENERAL SITE CONDITIONS** |
|---|
| **A. Roads** ☒ Applicable ☐ N/A |
| **1. Roads damaged:** ☒ Location shown on site map ☒ Roads adequate ☐ N/A<br>Remarks:______ |
| **B. Other Site Conditions** |
| Remarks:______ |
| **VII. LANDFILL COVER/CONTAINMENT** ☒ Applicable ☐ N/A |
| **A. Landfill Surface** |
| **1. Settlement** (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident<br>Areal extent______ Depth______<br>Remarks:______ |
| **2. Cracks:** ☐ Location shown on site map ☒ Cracking not evident<br>Lengths______ Widths______ Depths______<br>Remarks:______ |
| **3. Erosion:** ☐ Location shown on site map ☒ Erosion not evident<br>Areal extent______ Depth______<br>Remarks:______ |
| **4. Holes:** ☐ Location shown on site map ☒ Holes not evident<br>Areal extent______ Depth______<br>Remarks:______ |
| **5. Vegetative Cover:** ☒ Grass ☒ Cover properly established ☒ No signs of stress<br>Areal extent______ Depth______<br>Remarks: Vegetation mowed routinely.______ |

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

| **VII. COVER SYSTEMS *(Continued)*** |
|---|
| **6. Alternative Cover (armored rock, concrete, etc.):** ☒ N/A<br>Remarks:__________ |
| **7. Bulges:** ☐ Location shown on site map ☒ Bulges not evident<br>Areal extent__________ Depth__________<br>Remarks:__________ |
| **8. Wet Areas / Water Damage:** ☒ Wet areas/water damage not evident<br>☐ Wet areas ☐ Location shown on site map Areal extent__________<br>☐ Ponding ☐ Location shown on site map Areal extent__________<br>☐ Seeps ☐ Location shown on site map Areal extent__________<br>☐ Soft subgrade ☐ Location shown on site map Areal extent__________<br>Remarks:__________ |
| **9. Slope Instability:** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability<br>Areal extent__________<br>Remarks:__________ |
| **B. Benches** ☐ Applicable ☒ N/A<br>(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel) |
| **C. Letdown Channels** ☐ Applicable ☒ N/A<br>(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies) |

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

| **VII. LANDFILL COVER/CONTAINMENT *(Continued)*** |
|---|
| **D. Cover Penetrations** ☒ Applicable ☐ N/A |
| **1. Gas Vents:** ☐ Active ☐ Passive<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A<br>Remarks:______ |
| **2. Gas Monitoring Probes:**<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A<br>Remarks:______ |
| **3. Monitoring Wells:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A<br>Remarks:______ |
| **4. Leachate Extraction Wells:**<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A<br>Remarks:______ |
| **5. Settlement Monuments:** ☐ Located ☐ Routinely Surveyed ☒ N/A<br>Remarks:______ |
| **E. Gas Collection and Treatment** ☐ Applicable ☒ N/A |
| **F. Cover Drainage Layer** ☐ Applicable ☒ N/A |
| **G. Detention/Sedimentation Ponds** ☐ Applicable ☒ N/A |
| **H. Retaining Walls** ☐ Applicable ☒ N/A |

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

| VII. LANDFILL COVER/CONTAINMENT *(Continued)* |
|---|
| **I. Perimeter Ditches/Offsite Discharge** ☒ Applicable ☐ N/A |
| **1. Siltation:** ☐ Location shown on site map ☒ Siltation not evident<br>Areal extent__________ Depth__________<br>Remarks:__________ |
| **2. Vegetative Growth:** ☐ Location shown on site map ☐ N/A<br>☒ Vegetation does not impede flow<br>Areal extent__________ Type__________<br>Remarks:__________ |
| **3. Erosion:** ☐ Location shown on site map ☒ Erosion not evident<br>Areal extent__________ Depth__________<br>Remarks:__________ |
| **4. Discharge Structure:** ☐ Location shown on site map ☒ N/A<br>Remarks:__________ |
| **VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A |
| **IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A |
| **A. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **C. Treatment System** ☐ Applicable ☒ N/A |
| **D. Monitoring Data** ☒ Applicable ☐ N/A |
| **1. Monitoring Data:**<br>☒ Is routinely submitted on time ☒ Is of acceptable quality |
| **2. Monitoring Data:**<br>☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining |
| **E. Monitored Natural Attenuation** ☒ Applicable ☐ N/A |
| **1. Monitoring Wells** *(natural attenuation remedy)***:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition<br>☒ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks:__________ |

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

| **IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*** |
|---|
| **F. Monitoring Data** ☒ Applicable ☐ N/A |
| **3. Monitoring Data:**<br>☒ Is routinely submitted on time ☒ Is of acceptable quality |
| **4. Monitoring Data:**<br>☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining |
| **G. Monitored Natural Attenuation** ☒Applicable ☐ N/A |
| **2. Monitoring Wells** *(natural attenuation remedy)***:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition<br>☒ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks:__________ |
| **X. OTHER REMEDIES** |
| If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. |
| **A. Soil Vapor Extraction System** ☐ Applicable ☒ N/A |
| **1. Blowers, Wellhead Plumbing, and Electrical:**<br>☐ Good Condition ☐ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks: SVE units have concluded operations__________ |
| **2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:**<br>☐ Good Condition ☐ Needs maintenance<br>Remarks:__________ |
| **3. Spare Parts and Equipment:**<br>☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided<br>Remarks:__________ |

**Attachment D-1. Five-Year Review Site Inspection Checklist – Chemicals, Metals, and Pesticides (CMP) Pits (080-170G, -171G, -180G, -181G, -182G, -183G, and -190G) Operable Unit *(continued)***

| **XI. OVERALL OBSERVATIONS** |
|---|
| **A. Implementation of the Remedy** |
| Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).<br><br>The selected remedial action for groundwater is MNA and LUCs to control human exposure to contaminated groundwater above MCLs; the selected remedy for the Ballast Area of LUCs is to prevent direct contact to PCB-contaminated soils above concentrations of 1 mg/kg. A combination of ERH to remove DNAPL and continued operation of the SVE system for Source Area (Field A) and of the passive soil vapor extraction system via BaroBalls$^{TM}$ for Source Area (Field B) has concluded their operation. MNA effectively remediates the low-concentration residual groundwater contamination that remains following implementation of the source control remedial action. LUCs are in place and being implemented to provide access control and prevent exposure as designed. In conclusion, the selected remedies for the CMP Pits are functioning as intended. |
| **B. Adequacy of O&M** |
| Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.<br><br>The O&M procedures consisting of annual site inspections and site maintenance (repair of erosion damage, cover maintenance, and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. The O&M procedures are adequately maintaining the integrity of the MNA. There are no issues requiring corrective actions. |
| **C. Early Indicators of Potential Remedy Failure** |
| Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.<br><br>N/A |
| **D. Opportunities for Optimization** |
| Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.<br><br>N/A |

***End of Checklist***

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## D-AREA OIL SEEPAGE BASIN (631-G) OPERABLE UNIT

### I. Introduction

This report is the fifth five-year review for the D-Area Oil Seepage Basin (631-G) (DOSB) Operable Unit (OU). The review was conducted from August 2015 through November 2015. DOSB currently meets unrestricted land use criteria for soils, sediment, and surface water. However, groundwater contaminants at the DOSB OU are at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the DOSB OU is protective of human health and the environment. This report documents the results of the review.

### II. Operable Unit Chronology

Table E-1 lists the chronology of site events for the DOSB OU.

### III. Background

The DOSB OU is a Resource Conservation Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act unit listed in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media associated with this OU are soil and groundwater.

#### Physical Characteristics

The DOSB OU is located within SRS in a clearing, approximately 1.6 km (1 mi) north of the coal-fired D-Area Powerhouse (484-D) and approximately 3 km (1.9 mi) from the nearest SRS boundary (Figure E-1). The DOSB was constructed in 1952 as a series of unlined trenches to dispose of waste oil products. The DOSB is approximately 114.9 m (383 ft) long by 32.4 m (108 ft) wide and 2.4 m (8 ft) deep (Figure E-2). During an interim remedial action (IRA) conducted at the unit, the trenches were found to be continuous, without noticeable berms, and were constructed as a series of adjacent trenches along the back half of the clearing.

The groundwater beneath the DOSB is included in the OU. The DOSB is on the Ellenton Plain along the Savannah River at an elevation of 45 m (150 ft) above mean sea level (msl). The terrain is flat, with no discernible slope or relief, and is surrounded by a mature forest of hardwoods and softwoods. The water table ranges from approximately 1.2 to 4.8 m (4 to 16 ft) below ground surface (bgs) in the area of the DOSB. The water table aquifer system in this area is composed of the sands of Dry Branch, Santee, and Clinchfield Formations and is in the lower aquifer zone (LAZ) of the Upper Three Runs Aquifer (UTRA). Locally, the LAZ of the UTRA is subdivided into three aquifer zones: AQ1, AQ2, and AQ3. The Gordon Aquifer Unit (GAU) lies beneath the Gordon Confining Unit. The Gordon Confining Unit is below the LAZ. Surface drainage is to the southwest, toward the Savannah River, which is at an elevation of 25.5 m (85 ft) msl. The closest surface water feature is a Carolina bay, a natural wetland located adjacent to the unit to the west (Figure E-2). The Carolina bay appears to be dry during the summer months or periods of little to no precipitation, but it may contain surface water during wet seasons. Other wetlands exist approximately 75 m (250 ft) south of the unit (Figure E-2). The major local surface water drainage system is the Savannah River and associated swamps, located approximately 2.6 km (1.6 mi) west of the unit (Figure E-1). Upper Three Runs Creek, a tributary to the Savannah River, is located 2.6 km (1.6 mi) to the north-northwest, and Fourmile Branch, another tributary, is located 2.4 km (1.5 mi) to the south-southeast (Figure E-1).

### Land and Resource Use

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The Land Use Control Assurance Plan (LUCAP) for the SRS (WSRC 1999a) designates the DOSB OU as being within an industrial area. The future land use for the DOSB OU is reasonably anticipated to remain industrial with the U.S. Department of Energy (USDOE) maintaining control of the land.

**History of Contamination**

Prior to SRS ownership, the DOSB area was primarily used for agriculture. In 1952, the DOSB trenches began receiving waste oils and fluids from A-Area and other areas at SRS which were unacceptable for incineration in the 400-D powerhouse boilers. The waste was periodically burned along with general office and cafeteria waste. There is no evidence that the DOSB received radioactive waste. Figure E-3 is a photograph of one of the trenches during its operational period. In 1975, the basin was removed from service and backfilled with soil. The basin remained inactive and covered with natural vegetation, including bushes and grasses. During a limited scope characterization in 1993, 58 buried 55-gallon drums suspected to contain hazardous substances were discovered.

**Initial Response**

A preliminary unit evaluation and a unit reconnaissance were performed in August 1988. Since the preliminary unit evaluation concluded that the unit had received hazardous substances, a unit screening investigation was implemented and field investigations conducted between 1988 and 1994. The field investigations involved soil borings, surface geophysics, well and piezometer installation, and groundwater sampling.

Groundwater and soil sampling were performed in 1996 as part of the RCRA Facility Investigation/Remedial Investigation (RFI/RI). The investigation revealed soils contamination in the trenches and a plume of volatile organic compounds (VOCs) in the groundwater. The RFI/RI Report and the Baseline Risk Assessment (BRA) Report for the DOSB (WSRC 1997a) identified eight VOCs as final constituents of concern (COCs): benzene, 1,1-dichloroethylene (DCE), total 1,2-DCE, cis-1,2-DCE (cDCE), dichloromethane, tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride (VC). An IRA (WSRC 1995) was implemented in 1996 and included:

- Removing drums, debris, and principal threat source material (PTSM), transferring drum contents into new drums, and properly disposing of all hazardous and non-hazardous materials.

- Backfilling, grading, and seeding the basin in accordance with the Remedial Design/Remedial Action Work Plan (WSRC 1996). The DOSB was graded and seeded to ensure stormwater would runoff to minimize water infiltration and to minimize erosion.

- Installing and testing a biological treatment system (i.e., bioventing system) to volatilize the contaminants in the soil and enhance the aerobic degradation of the contaminants in the soil.

### Basis for Taking Action

The potential exposure to or ingestion of groundwater contaminated above maximum contaminant levels (MCLs) poses a potential increased risk of cancer to human receptors and is the basis for taking action at the DOSB OU. Although shallow groundwater aquifers at SRS are not used as a drinking water source, the potential for unacceptable human exposure to contaminated groundwater exists as long as contaminants remain at levels above MCLs.

## IV. Remedial Actions

### Remedy Selection

As stated in the Record of Decision (ROD) (WSRC 1998), the selected remedy for the DOSB OU is monitored natural attenuation (MNA)/groundwater mixing zone (GWMZ) with institutional controls. The ROD identifies COCs for groundwater only because the remedial action objectives (RAOs) for deep soil were achieved by the IRA. Methylene chloride was initially identified as a soil COC but concentrations were reduced to levels that would not leach to groundwater above the MCLs through the IRA. For this reason, methylene chloride was not identified as a final COC for deep soils in the ROD. In addition, no COCs were identified for shallow soil, surface water, and sediment during the RFI/RI and BRA (WSRC 1997a). Remedial goals (RGs) for groundwater COCs were determined to be equivalent to their respective maximum contaminant level (MCL) values in all monitoring wells. The groundwater contaminants at the DOSB OU and their corresponding RGs are provided in Table E-2. The RAOs for the groundwater are:

- Reduce risk to human health associated with dermal contact and ingestion of groundwater and inhalation of groundwater vapor; and
- Restore groundwater to achieve Applicable or Relevant and Appropriate Requirements (ARARs) and RGs.

As stated in the ROD (WSRC 1998), the selected remedial action is as follows:

- DOSB deep soils - No Further Action since RAOs were achieved by the IRA and bioventing testing;
- DOSB shallow soil, surface water and sediment – No Action because no COCs in those media were identified in the RFI/RI Report and BRA; and
- DOSB groundwater - MNA/ GWMZ with institutional controls.

Natural attenuation mechanisms such as biodegradation, flushing, volatilization, adsorption, and hydrolysis would continue to reduce contaminant concentrations in the groundwater to acceptable levels. The source of groundwater contamination (i.e., DOSB soil) no longer contributes to groundwater contamination as a result of the interim action and bioventing test.

**Remedy Implementation**

The final remedial action consisted of the following activities:

- Accepting the interim actions of removing 612 $m^3$ (800 $yd^3$) of debris, including 58 drums, and treating 9,371 $m^3$ (12,250 $yd^3$) of deep basin soils as final actions;
- Establishing an MNA/GWMZ by implementing a compliance groundwater monitoring program in accordance with the Corrective Measures Implementation/ Remedial Design/Remedial Action Work Plan (WSRC 1999b);

- Establishing institutional controls to control unauthorized access to DOSB groundwater including site control of groundwater well installations through existing SRS procedures, the existing SRS security controls and perimeter fences and use of restrictions via the SRS Site Use/Site Clearance Program; and
- Establishing land use controls (LUCs) for 9.35 hectares (23.04 acres) (WSRC 1997b).

Figure E-4 is a current photograph of the OU in 2015.

**Systems Operations/Operation and Maintenance**

There are no system operational requirements at the DOSB OU. DOSB currently meets unrestricted land use criteria for soils, sediment, and surface water. However, groundwater contaminants at the DOSB OU are at levels that do not allow for unlimited use and unrestricted exposure. LUCs are in place for the groundwater. Therefore, annual site inspections and maintenance (e.g., repair of erosion damage, cover maintenance, removal of trees and warning signs) are not required for soils, sediment, and surface water. Site inspections performed are for the monitoring wells and the 5-Year Remedy Review Reports.

For DOSB groundwater, a compliance groundwater monitoring program has been established to demonstrate compliance with MCLs at the compliance boundary and compliance with the mixing zone contaminant levels (MZCLs) at the plume wells as required by the GWMZ application and the ROD. All monitoring and reporting is in accordance with the GWMZ application (SRNS 2009).

The ROD estimated operations and maintenance (O&M) costs associated with the selected remedy for DOSB has a present worth of $299,000, which was discounted at 5% per year for 30 years of maintenance activities (WSRC 1998). The estimated O&M costs applicable to FY2012 through FY2015 are $67,866. The actual O&M cost from FY2012 until FY2015 is $216,204. The actual O&M costs (Table E-3) are higher than expected because groundwater monitoring and reporting costs are higher than estimated. Additionally, the ROD estimate was based on monitoring 12 locations for VOC analyses, while 23 wells are monitored for VOC analyses and additional natural attenuation field parameters.

## V. Progress Since Last Review

The previous protectiveness statement concluded that because the remedial actions at DOSB OU are protective, the site is protective of human health and the environment. Updated transport modeling conducted as part of the Revision 1.5 to the GWMZ Application revised the projection for completing the groundwater cleanup from the year 2010 to within 20 years (i.e. 2029) (SRNS 2009). Once remediation is complete and groundwater RGs (i.e., MCLs) are achieved in all monitoring wells, institutional controls (i.e., LUCs) will no longer be needed. In the interim, exposure pathways that could result in unacceptable risks are being controlled through access controls and use restrictions via the SRS Site Use/Site Clearance Program.

No information has come to light that could call into question the protectiveness of the remedy.

Monitoring data indicates that the remedy is still effective.

## VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed documents listed in Section XII, Documents Reviewed;
- Confirmed effective operation of the implemented Remedial Actions;
- Reviewed the groundwater data to determine the suitability of the mixing zone in evaluating whether MNA will foster reaching MCLs for the COCs in the DOSB groundwater;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist provided in Attachment E-1_with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and

- Reviewed changes in standards and to-be-considered guidance.

***Data Review***

The interim actions of removing drums, debris, and PTSM and conducting a bioventing test were effective in achieving RGs for the DOSB deep soils and removing the source of contamination to the groundwater. The bioventing optimization test, performed during Fall 1996 to Spring 1997, was effective in achieving the soil RG. Thus, no additional actions were needed to maintain the contaminant migration COC levels below the RG. The last IRA Semiannual Groundwater Monitoring Report (WSRC 1999c), documented the results of the interim removal actions and bioventing test in accordance with the Interim Action Record of Decision (IROD) (WSRC 1995). The bioventing test data verified that “no further action” was appropriate for DOSB deep soils. Post-test soil sampling found that in 26 of 27 samples, the methylene chloride concentration was less than 7 µg/kg. The concentration in the one remaining sample was 28.1 µg/kg, which is below the 41µg/kg RG (WSRC 1997c) and well below the pre-interim action maximum soil concentration of 2,140 µg/kg (WSRC 1997a).

For evaluating the MNA/GWMZ effectiveness, groundwater data from 2012 through 2015, the Revision 1.5 to the groundwater mixing zone application (SRNS 2009), the RFI/RI with BRA report (WSRC 1997a), and the annual mixing zone report for 2013 (SRNS 2014), which includes time series plots and hydrographs, were reviewed. During the period 2012 through 2015, benzene and methylene chloride had 77 and 90 records that were below detection limits, respectively. For benzene, there were 3 detects and 11 estimated (J-Qualified) values. For methylene chloride, there were 0 detects and 1 estimated (J-Qualified) value. All detects and estimated values were below the MCL (5 µg/L).

Per the flow and transport modeling effort (WSRC-RP-2004-4104, Revision 0, September 2004), the contaminated plumes were simulated for 50-years with no continuing sources contributing to groundwater contamination (consistent with source removal in 1996). The model predicted that PCE, TCE, DCE, and VC concentrations in the plume would be below their respective MCLs in 2027. Per the *2013 Annual Mixing*

*Zone Monitoring Report for the D-Area Oil Seepage Basin (631-G) (U)* (SRNS-RP-2014-00530, Revision 0, July 2014), groundwater contaminant data continues to exist within the parameters predicted in the modeling.

In order to evaluate the remainder of the contaminants and the effectiveness of the MNA remedy, the data were reviewed from several perspectives. The 1996 plume maps (WSRC 1997a) for PCE, TCE, and VC were compared with the 2011 and 2014 plume maps (SRNS 2012 and SRNS 2015) (Figures E-5 through E-13). The following were determined from this review:

- The PCE plume in the AQ1/2, AQ3, and GAU aquifers continue to move slowly through the aquifer. Concentrations of PCE continue to slowly decrease or remain similar to concentrations from previous sampling (Figures E-5 through E-7). PCE concentrations do increase in some areas as residual slugs of contamination move through the aquifer system. Those concentrations that exceed the PCE MCL (5 µg/L) are less than the DOSB MZCL (78 µg/L);

- The TCE plume in the AQ1/2,AQ3, and GAU aquifers continue to move slowly through the aquifer. Concentrations of TCE continue to slowly decrease or remain similar to concentrations from previously sampling, particularly in AQ3 and GAU. However, TCE concentrations do increase in some areas as residual mass of contamination move through the AQ1/2 aquifer system. Those concentrations that exceed the TCE MCL (5 µg/L) are less than the MZCL (200 µg/L);

- The VC 2 µg/L contour in the AQ1/2 aquifer appears relatively stable with little movement downgradient. However, an increase in concentration is expected as residual mass of contamination moves through the AQ1/2 and AQ3 systems. No detects of VC are found in the GAU. Those concentrations that exceed the VC MCL (2 µg/L) are less than the MZCL (147 µg/L).

In terms of evaluating VOC concentrations of parent to daughter compounds, concentrations of PCE vs. TCE and TCE vs. cDCE were compared (Figures E-14 and E-15). As shown in Figure E-14, monitoring well data with the highest VOC concentrations demonstrates a significant change from parent to daughter VOCs over time. Alternatively, the wells with relatively low VOC concentrations tend to have relatively constant ratios of the parent and daughter VOC concentrations (Figure 11). These results suggest that when the groundwater is contaminated with significant concentrations of VOCs, degradation occurs rather rapidly. However when the VOC concentrations are low, the degradation rate is also low. Figures E-10 and E-11 indicate that degradation from PCE to TCE and TCE to cDCE is occurring in the groundwater at the DOSB OU.

As stated in the GWMZ application (SRNS 2009), reductive dechlorination is not considered a continuous viable process at DOSB. At SRS, groundwater aquifers are normally depleted in natural carbon. However, petroleum hydrocarbons and chlorinated solvents were co-disposed with PCE and TCE at the DOSB (1952-1975), which provided an "optimum" situation for the reductive dechlorination of PCE and TCE in groundwater. Biodegradation of PCE and TCE likely occurred in the vadose zone, but the water table is shallow at the DOSB (2.4-4.5 m [8-15 ft] bgs). Thus, the pathway to groundwater is relatively short. At the DOSB, past biogeochemical zonation may have included reductive dechlorination zones near the source, followed by oxidative degradation of vinyl chloride at some point downgradient. Over time and with the source removal/treatment of DOSB (1995-1997), the concentrations of PCE and TCE have significantly declined, as well as the concentrations of the petroleum hydrocarbons themselves.

The co-disposal of petroleum hydrocarbons provided a ready carbon source for biological degraders, and the presence of degradation products (cis-1,2-DCE and vinyl chloride) in the plume wells suggest that past biodegradation has effectively degraded the parent compounds. Since the source of the carbon has become depleted, groundwater has reverted back to natural aerobic conditions in the existing carbon-poor environment. Overall, data do not show reductive dechlorination as a viable process. However, it is possible that reductive dechlorination is still occurring at the DOSB in discrete zones near the source and in "pockets" along the centerline of the plume. Natural attenuation at the DOSB relies mainly on physical processes (dispersion/dilution), except for aerobic degradation of vinyl chloride.

The 2014 natural attenuation field parameters (pH, oxidation-reduction potential [ORP], dissolved oxygen [DO], and alkalinity) are shown in Table E-4. For evaluation, trends for pH, ORP, DO, and alkalinity sampled between 2000 and 2006 are compared to the 2014 data are discussed below.

- In terms of pH, wells sampled between 2000 and 2006 had values of pH ranging from 3.5-7.8 while the 2014 data (Table E-4) show pH values ranging from 4.4-6.9. The pH of groundwater has an effect on the presence and activity of microbial populations in groundwater. This is especially true for methanogens. Microbes capable of degrading chlorinated aliphatic hydrocarbons and petroleum hydrocarbons generally prefer pH values ranging from 6 to 8.

- Data regarding ORP show that wells sampled between 2000 and 2006 had ORP values ranging from -30 to 600 while the 2014 data show ORP values ranging from -161 to 307. The ORP of groundwater is an indicator of the relative tendency of a solution to accept or transfer electrons. Redox reactions in groundwater containing organic compounds are usually biologically mediated, and therefore, the ORP of a groundwater system depends upon and influences rates of biodegradation. In addition, ORP is important because some biological processes operate only within a prescribed ORP range. Reductive dechlorination typically occurs at a ORP range of -200 to 50.

- With regard to DO, wells sampled between 2000 and 2006 had DO values ranging from 0-8.4 mg/L; while the 2014 data show DO values ranging from 0.54 to 6.01 mg/L. DO is the most thermodynamically favored electron acceptor used by microbes for the biodegradation of organic carbon, whether natural or anthropogenic. Anaerobic bacteria generally cannot function at DO concentrations greater than 0.5 mg/L, hence reductive dechlorination will not occur. DO concentrations decrease during aerobic respiration.

- For alkalinity, wells sampled between 2000 and 2006 had alkalinity values ranging from 0 to 180 while the 2014 data show alkalinity values of 0 to 95. There is a positive correlation between zones of microbial activity and increased alkalinity. Increases in alkalinity result from the dissolution of rock driven by the production of $CO_2$ produced by the metabolism of microorganisms. Alkalinity is important in the maintenance of groundwater pH because it buffers the groundwater against acids generated during both aerobic and anaerobic biodegradation. However, the biodegradation of organic compounds does not generate enough acid to impact the pH of groundwater.

In summary, the 2014 DOSB OU groundwater plumes have minimally changed and sampling data obtained during 2014 confirms that the existing GWMZ boundaries are adequate and continue to enclose the DOSB OU plumes.

***Summary of Inspections and Interviews***

Interviews were conducted with Richard Feagin, O&M staff member, on July 15, 2015 by phone and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The DOSB OU was inspected by SRNS and USDOE personnel on July 22, 2015 and November 3, 2015, respectively, as part of the Five-Year Remedy Review process. No issues were identified for the DOSB OU during this inspection.

## VII. Technical Assessment

### Is the Remedy Functioning as Intended by the Decision Document?

Review of documents, ARARs, risk assumptions, and results of the site inspection indicate that the remedy is functioning as intended by the ROD. The low concentration of contaminants, shrinking plumes, and relatively short half-lives indicate the MNA/GWMZ will be effective in restoring groundwater to ARARs and RGs. The timeframe for reaching RGs may be optimistic due to the effect of matrix diffusion.

As stated in the ROD (WSRC-RP-97-402, Revision 1, August 1998), the following conditions at the DOSB support that the selected remedy is adequate to meet the RGs within a reasonable timeframe:

- The source of contamination at the DOSB was removed during the Interim Remedial Action in conjunction with the biovent testing and is no longer contributing to groundwater contamination;
- Naturally occurring mechanisms will continue to reduce contaminant concentrations;
- There are no receptors of groundwater at the DOSB; therefore, the potential for exposure is low;
- The aquifer is limited in thickness and yield and the groundwater it contains is no targeted for residential or commercial use; therefore, projected demand for future groundwater use is low; and
- Modeling indicates that contaminant concentrations in the DOSB groundwater would be reduced to low MCLs prior to reaching Fourmile Branch; therefore, dilution in the surface water body is not necessary to achieve MCLs.

Institutional controls (i.e., LUCs) are effective in preventing exposure to groundwater and its vapor. The DOSB currently meets unrestricted land use criteria for soils, sediment, and surface water. Site inspections are performed for the monitoring wells and the Five-Year Remedy Review Reports. The results of the inspection for this five-year review indicate the controls are effective and no problems have occurred. The original gate and fencing around the DOSB perimeter, although still present, is not required.

**Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still Valid?**

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid except for the arsenic MCL. At the time of the ROD issuance, the MCL for arsenic was 50 µg/L. This value was changed in 2001 to 10 µg/L. There have been no changes in the MCL values for the eight groundwater COCs identified at the DOSB OU as shown in Appendix B. Therefore, there have been no changes that would impact the effectiveness of the MNA/GWMZ remedy for groundwater. The ARARs, which focus on meeting MCLs, GWMZ compliance limits, and protection of the nearby wetlands, will be met upon meeting the groundwater RGs.

Due to the presence of chlorinated solvents at the site, there is a potential that 1,4-dioxane may also exist because it is often added to chlorinated solvents as a stabilizer and corrosion inhibitor. The presence of 1,4-dioxane is not likely to change the protectiveness of the remedial action that includes LUCs (at a minimum) which consequently renders the exposure pathway to human receptors incomplete. An evaluation of the effectiveness of the remedy is premature until such time that a formal MCL is established. SRS has performed a historical review of groundwater data for the DOSB OU resulting in a single sampling event of five individual DOB wells in 1991 (two wells) and 2006 (three wells). The results indicated 1,4-dioxane was not detected. Based on recommendations made in the Fourth Five-Year Remedy Review, groundwater at the DOSB was to be sampled for 1,4-dioxane and reported in the subsequent groundwater monitoring report before the next Five-Year Remedy Review was submitted. However due to the submittals changes for the phased approach to the five-year remedy review submittals, 1,4-dioxane will not be sampled for at the DOSB before submittal of this Five-Year Remedy Review report. The 1,4-dioxane sampling will be conducted in the second quarter of 2016. Results from that sampling will be discussed in the 2016 DOSB Groundwater Report Letter to be submitted in July 2017.

More stringent 2015 preliminary remediation goals/regional screening levels (PRGs/RSLs) do not impact the protectiveness of the remedy because excavation of highly contaminated media and establishment of a clean soil cover eliminated the human health exposure pathway to remaining soil contaminants left in place. There have been no changes in the MCLs for TCE and PCE that would impact the effectiveness of the MNA/GWMZ remedy for groundwater. In addition, PRGs/RSLs that are more stringent would not impact the LUCs that are in place to prevent exposure to or ingestion of contaminated soil or groundwater media at the DOSB OU.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

Issues related to the DOSB are presented in Table E-5.

## IX. Recommendations and Follow-up Actions

Recommendations and follow-up actions for the DOSB are presented in Table E-6..

## X. Protectiveness Statement(s)

The remedy at the DOSB OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled through institutional controls (i.e., LUCs) such as physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls, and use restrictions via the SRS Site Use/Site Clearance Program to prevent exposure to or ingestion of contaminated groundwater. Protectiveness of the remedial action will be verified by continued groundwater monitoring.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater Remedies is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2009. *Groundwater Mixing Zone Application for the D-Area Oil Seepage Basin (631-G) (U)*, WSRC-RP-97-422, Revision 1.5, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *2011 Annual Mixing Zone Monitoring Report for the D-Area Oil Seepage Basin (631-G) (U)*, SRNS-RP-2012-00348, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *2013 Annual Mixing Zone Monitoring Report for the D-Area Oil Seepage Basin (631-G) (U)*, SRNS-RP-2014-00530, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

USDOE, 2015. *2011 D-Area Oil Seepage Basin (631-G) Groundwater Mixing Zone Letter Report for Calendar Year 2014 Data, CERCLIS Number: 27,* IACD-15-164, U.S. Department of Energy, Savannah River Operations Office, Aiken, SC

WSRC, 1995. *Interim Action Record of Decision/ Remedial Alternative Selection (U) D-Area Oil Seepage Basin*, WSRC-RP-93-1550, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1996. *Remedial Design/Remedial Action Work Plan for the D-Area Oil Seepage Basin (U),* WSRC-RP-94-1287, Revision 1.3, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997a. RCRA Facility Investigation/Remedial Investigation Report and the Baseline Risk Assessment Report for the D-Area Oil Seepage Basin (631-G) (U), WSRC-RP-96-154, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997b. *Post Construction Report for D-Area Oil Seepage Basin Interim Action (U)*, WSRC-RP-00859, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1997c. *Evaluation of D-Area Oil Seepage Basin Bioventing Optimization Test Sediment Samples Data*, WSRC-TR-97-00399, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1998. *Record of Decision Remedial Alternative Selection for the D-Area Oil Seepage Basin (631-G) (U)*, WSRC-RP-97-402, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999a. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, March 2013, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 1999b. Corrective Measures Implementation/Remedial Design/Remedial Design Report/Remedial Action Work Plan for the D-Area Oil Seepage Basin (631-G) (U) (includes Land Use Control Implementation Plan), WSRC-RP-99-4006, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 1999c. *Sixth Semi-Annual Groundwater Monitoring Report for the D-Area Oil Seepage Basin Interim Remedial Action (U)*, WSRC-RP-99-4207, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC.

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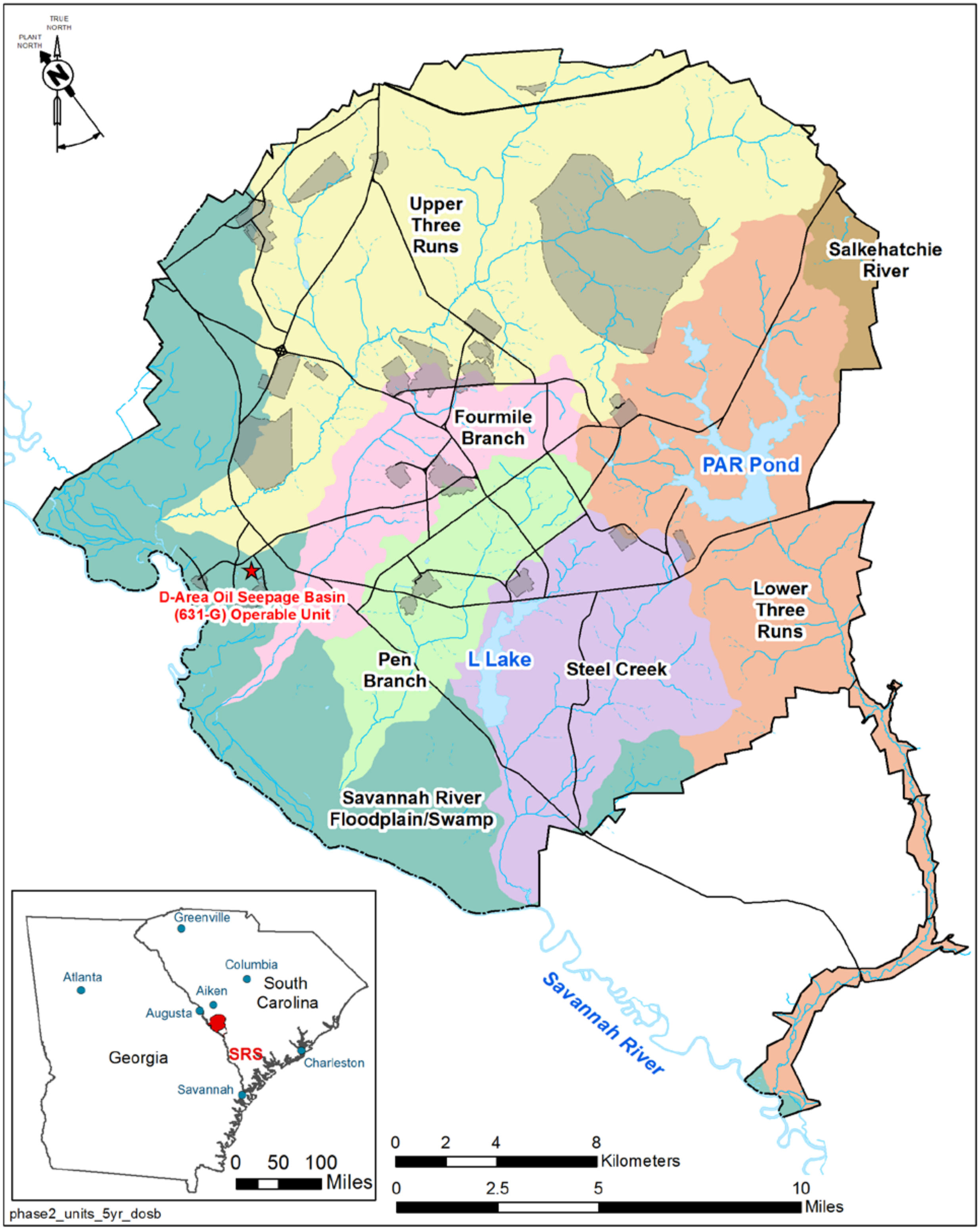



**Figure E-1. Location of the D-Area Oil Seepage Basin Operable Unit within SRS**

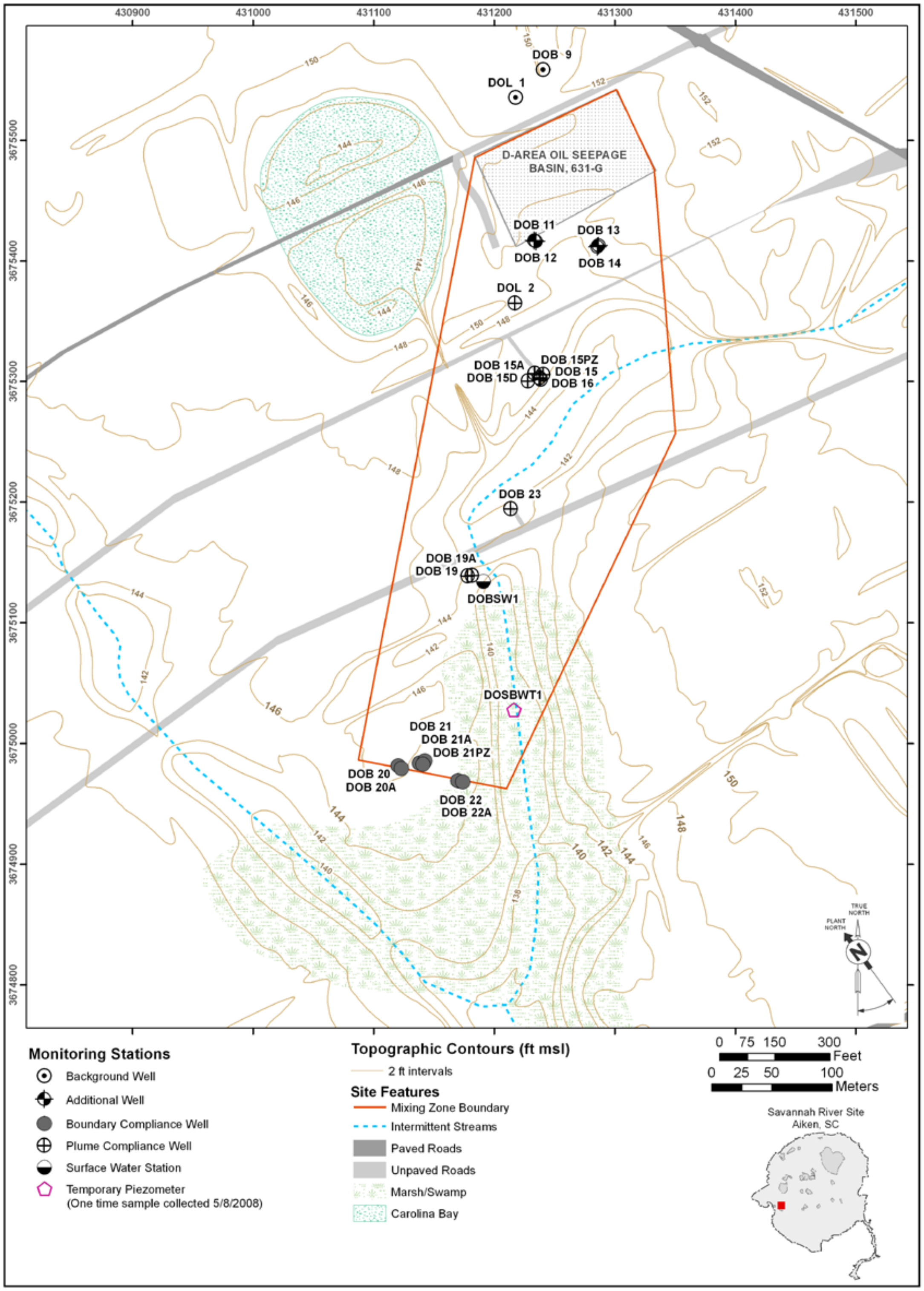



**Figure E-2. D-Area Oil Seepage Basin Monitoring Well Location Map**

**Figure E-3. Photo of the D-Area Oil Seepage Basins Prior to 1975 Backfill Operations**

**Figure E-4. Current (2015) Photograph of the DOSB.**

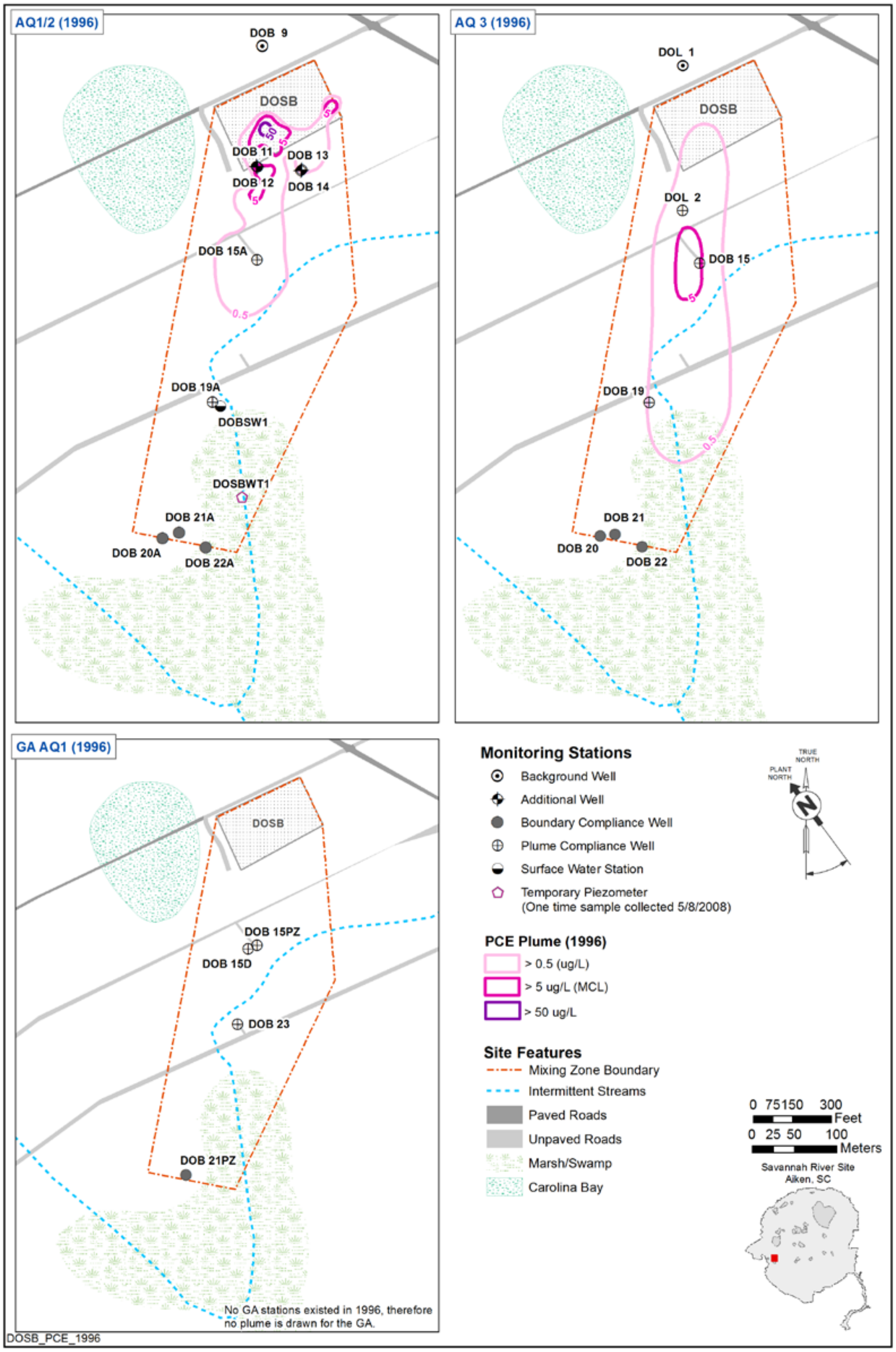



Figure E-5. DOSB PCE plume maps (1996 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (WSRC 1997a)

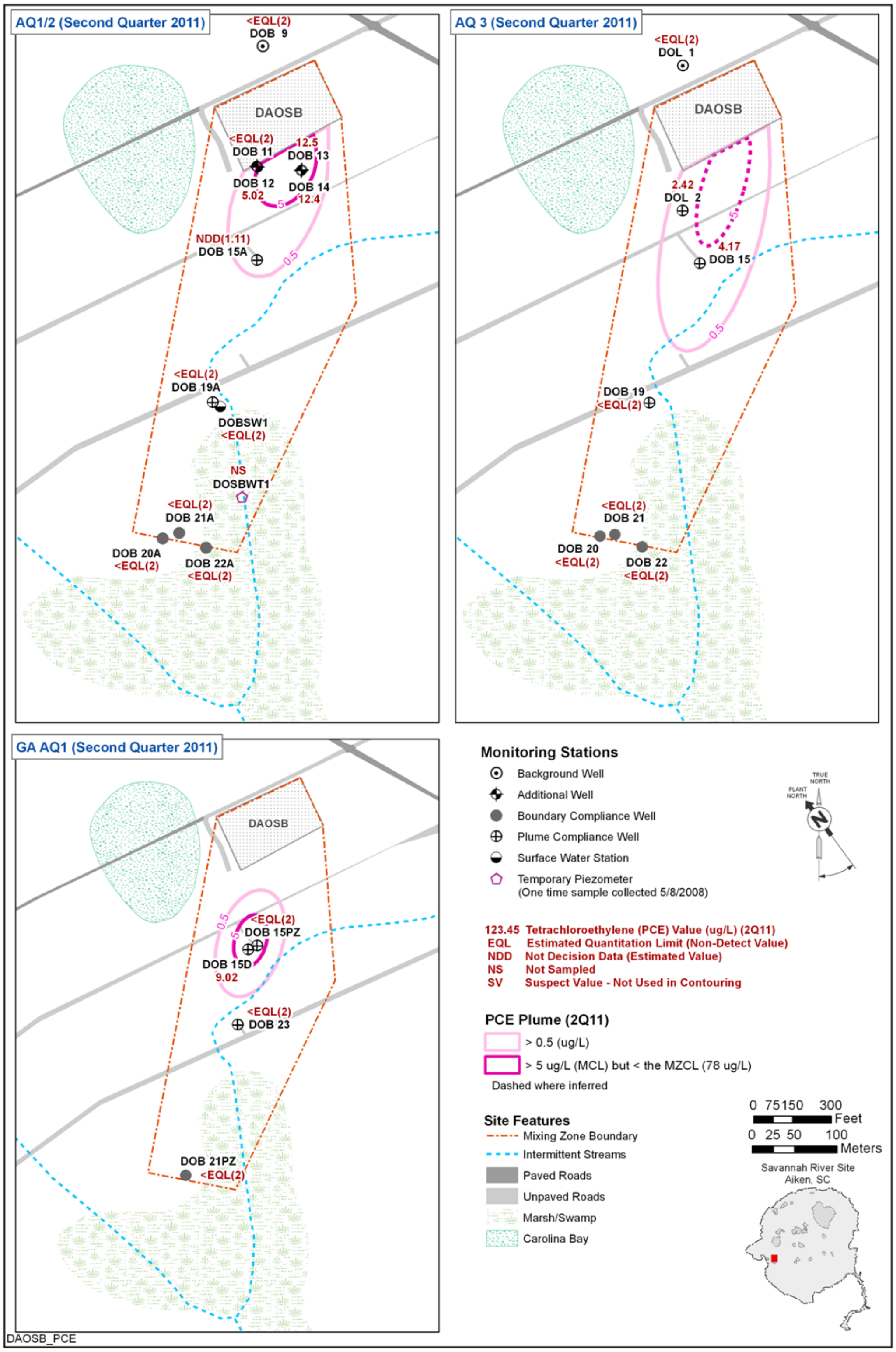



Figure E-6. DOSB PCE plume maps (2011 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (SRNS 2012)

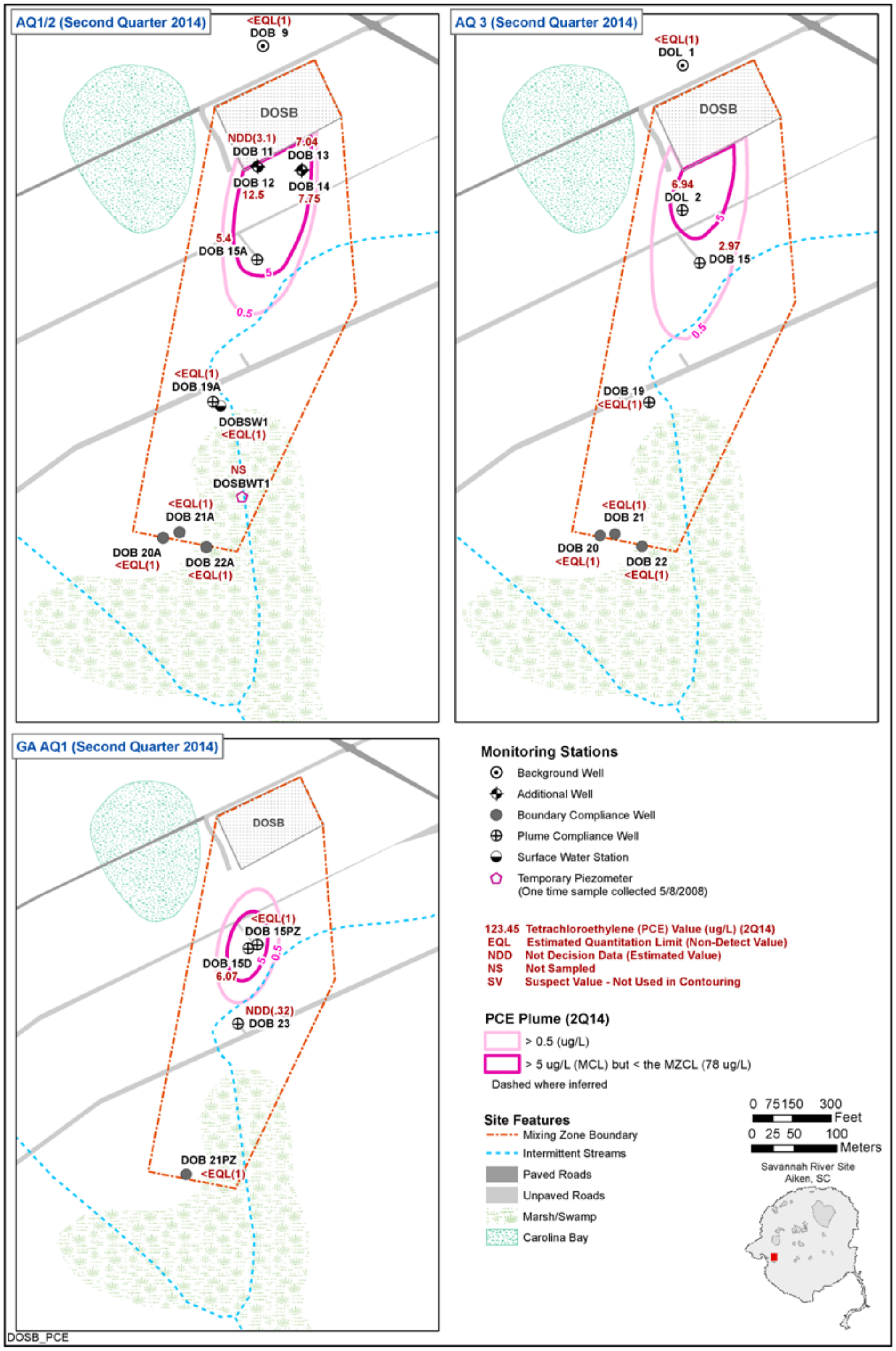



**Figure E-7. DOSB PCE plume maps (2014 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (USDOE 2015)**

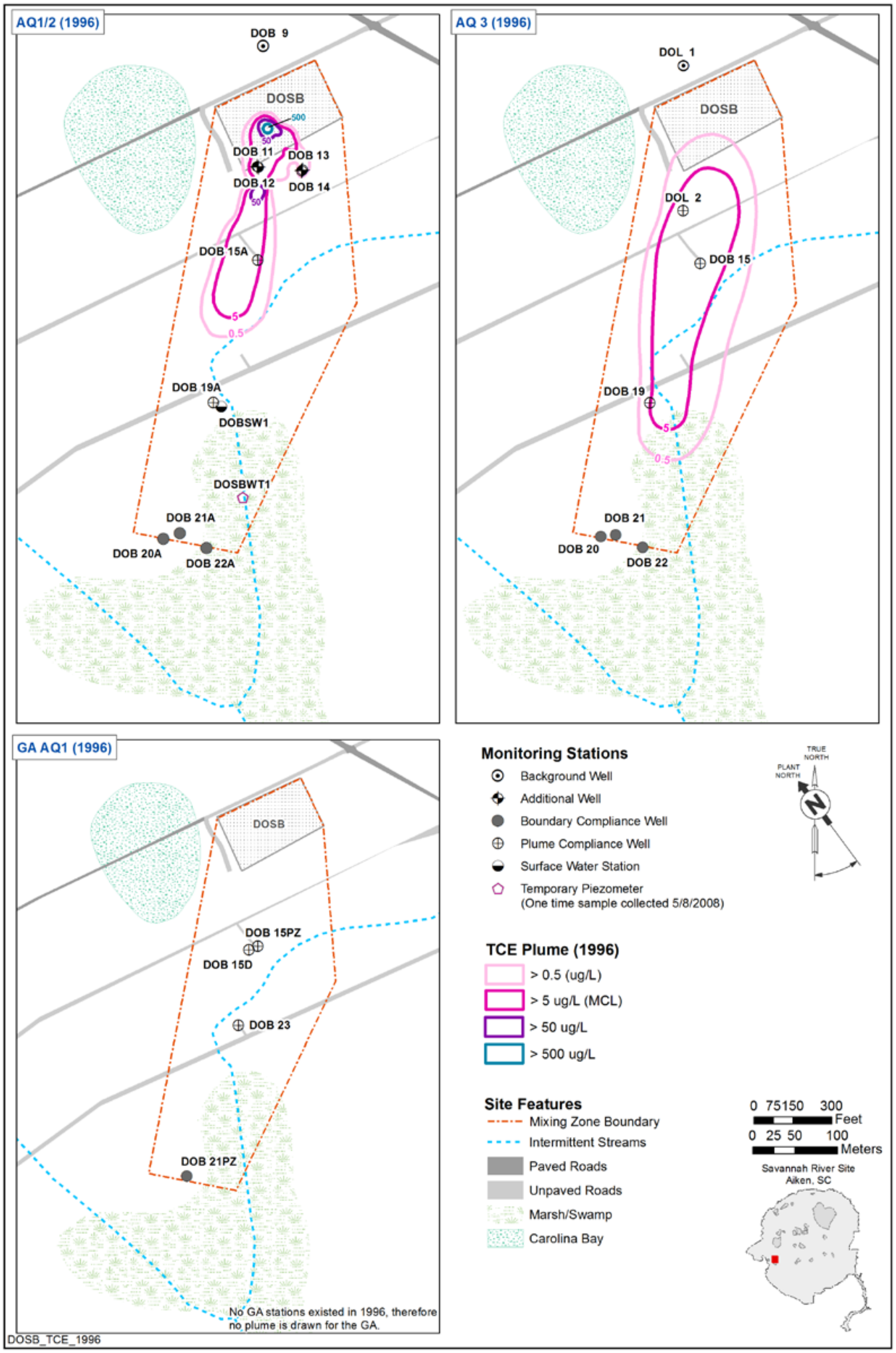



Figure E-8. DOSB TCE plume maps (1996 data) for Aquifers AQ1/2, AQ3, GA-AQ1 (WSRC 1997a)

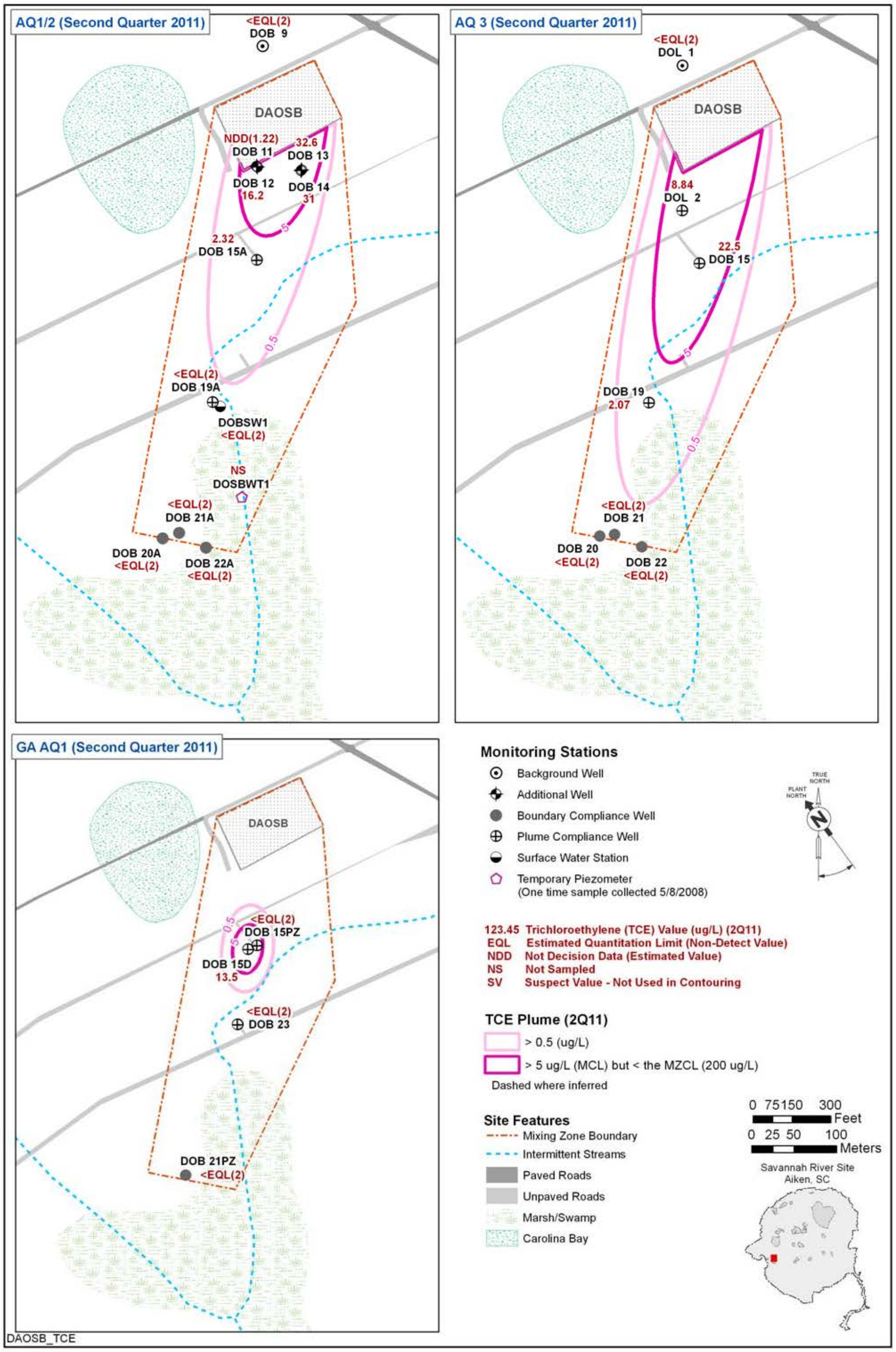



**Figure E-9. DOSB TCE plume maps (2011 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (SRNS 2012)**

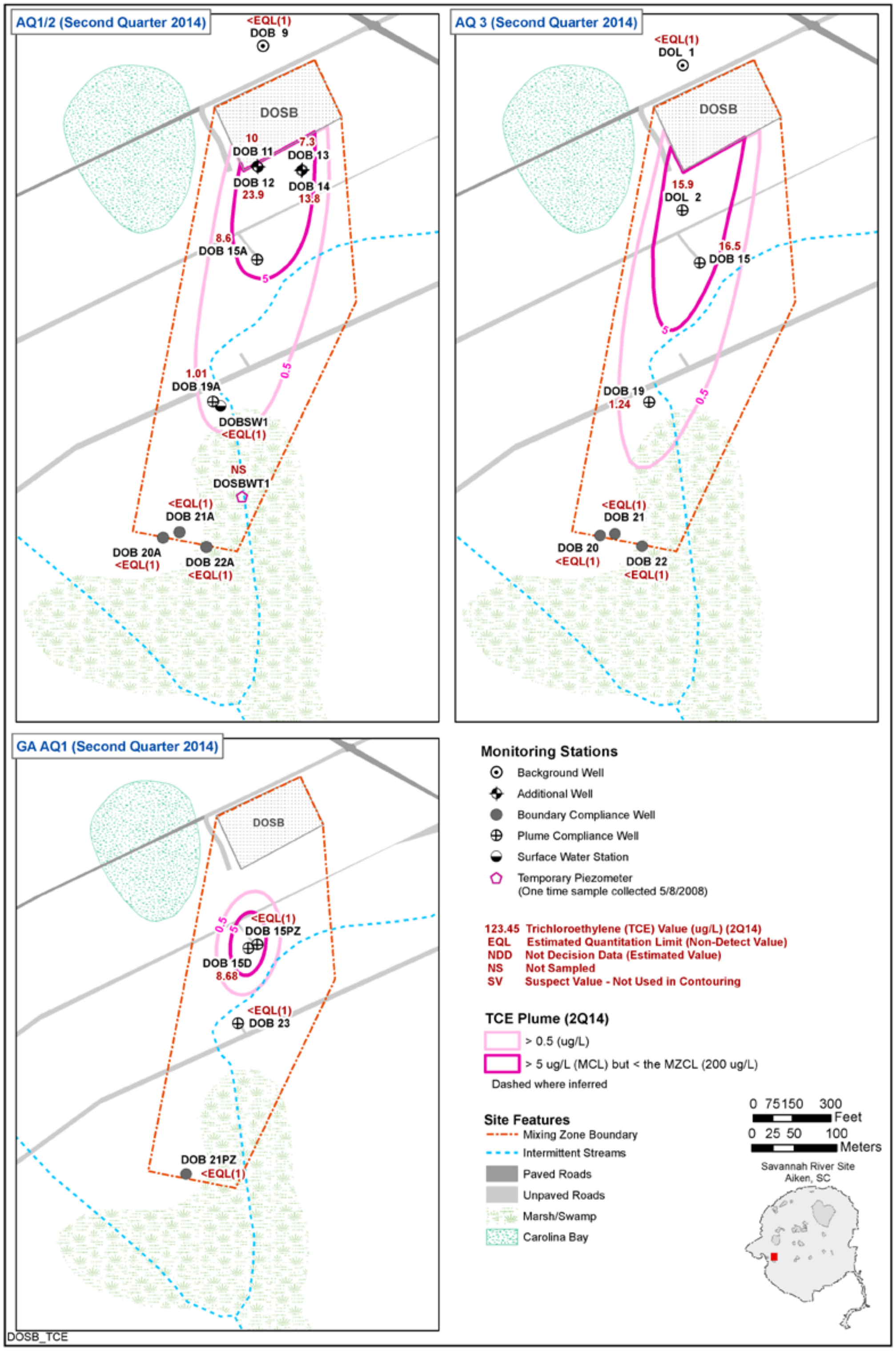



**Figure E-10. DOSB TCE plume maps (2014 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (USDOE 2015)**

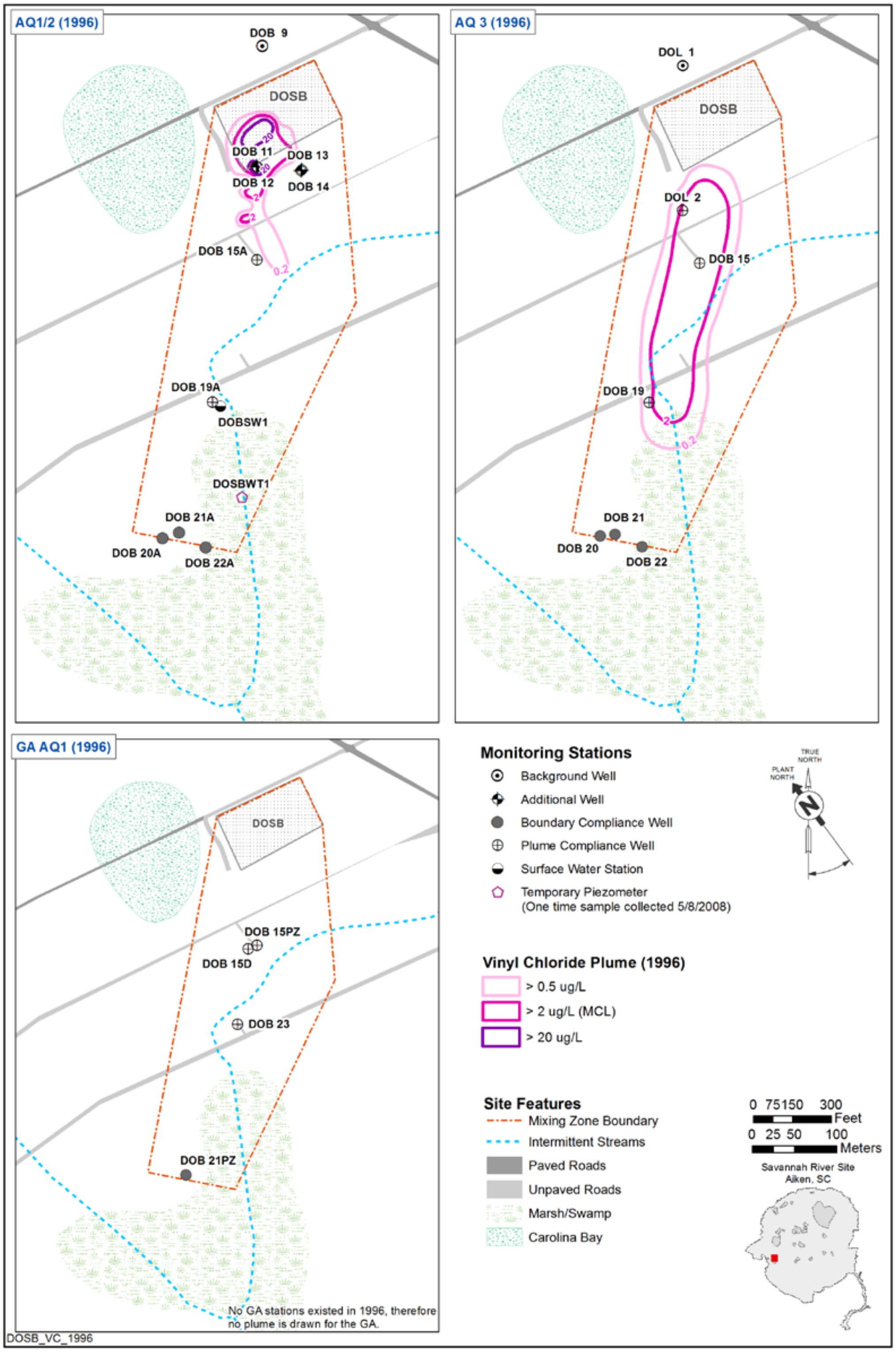



**Figure E-11. DOSB Vinyl Chloride Plume Maps (1996 data) for Aquifers AQ1/2, AQ3, and GA-AQ1 (WSRC 1997a)**

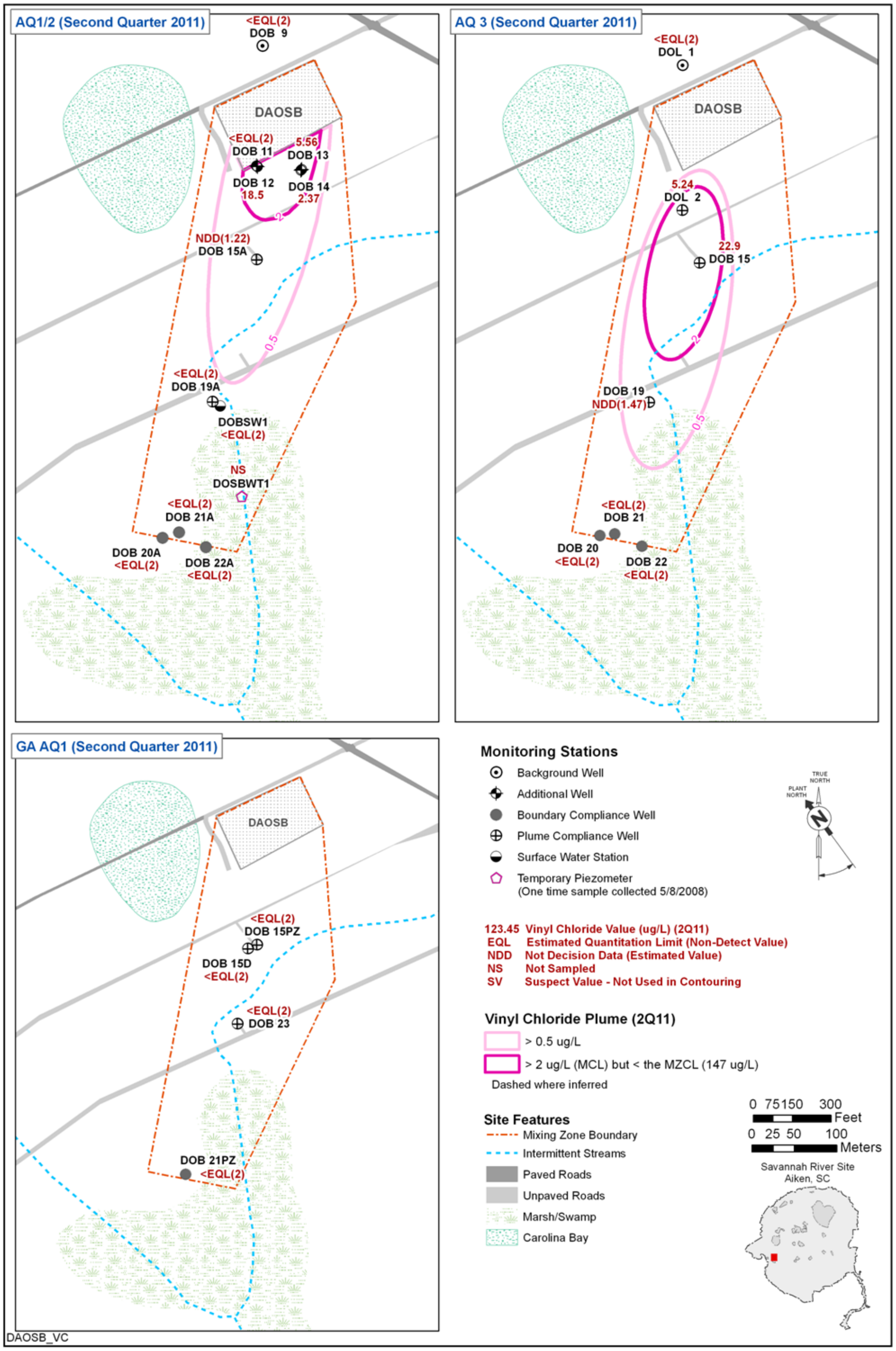



**Figure E-12. DOSB vinyl chloride plume maps (2011 data) for Aquifers AQ1/2, AQ3 and GA-AQ1 (SRNS 2012)**

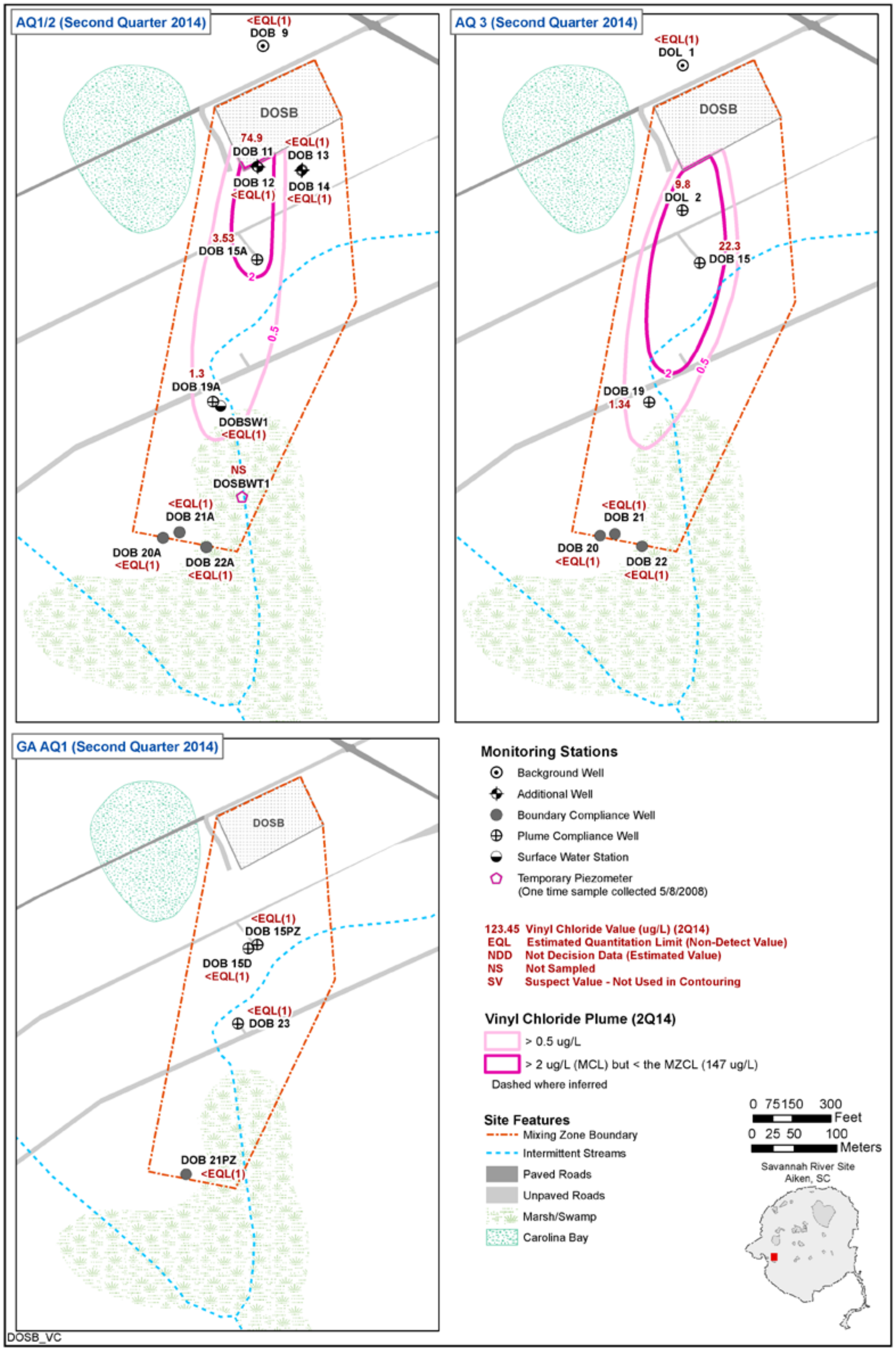



**Figure E-13. DOSB Vinyl Chloride Plume Maps (2014 data) for Aquifers AQ1/2, AQ3 and GA-AQ1 (USDOE 2015)**

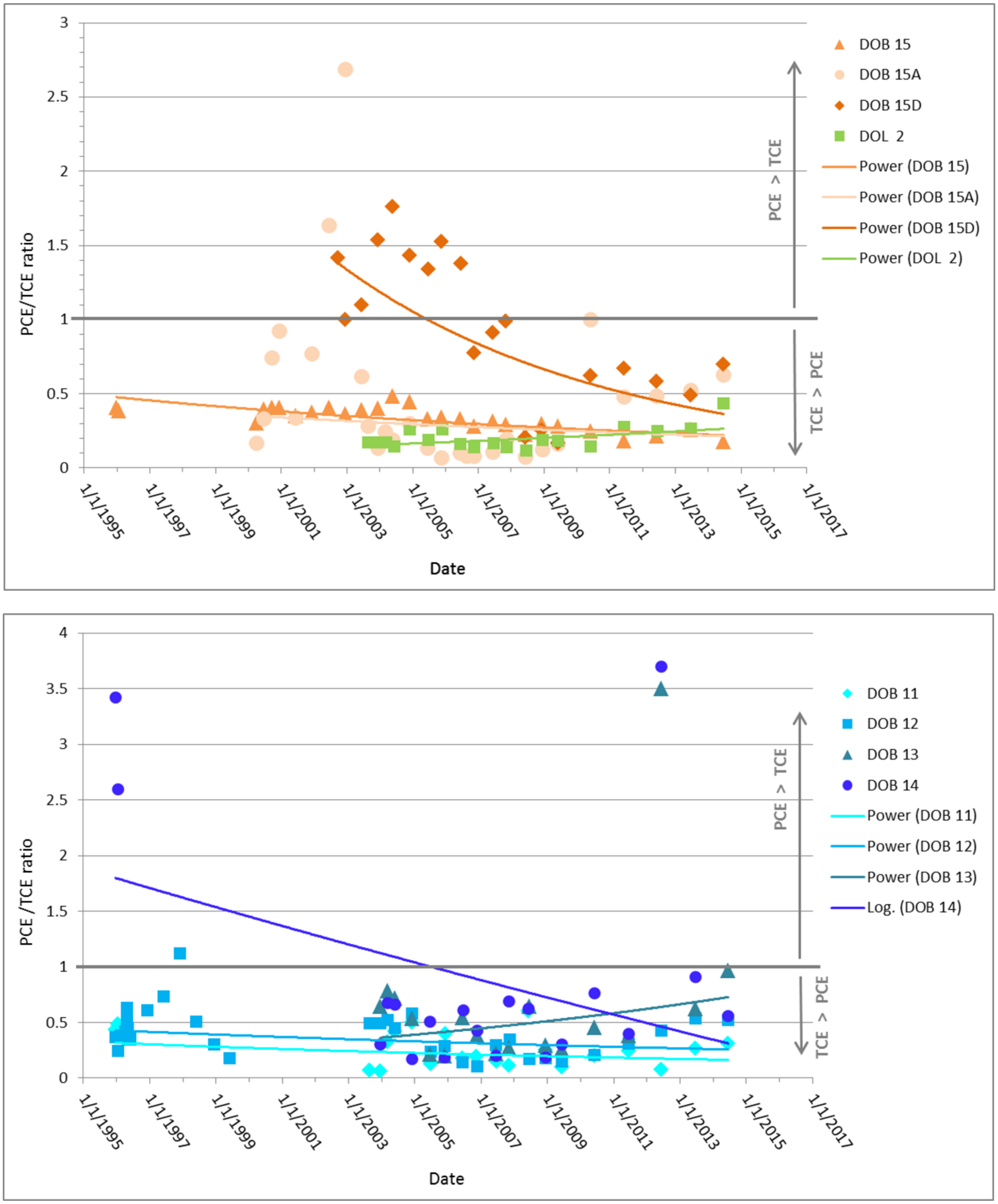
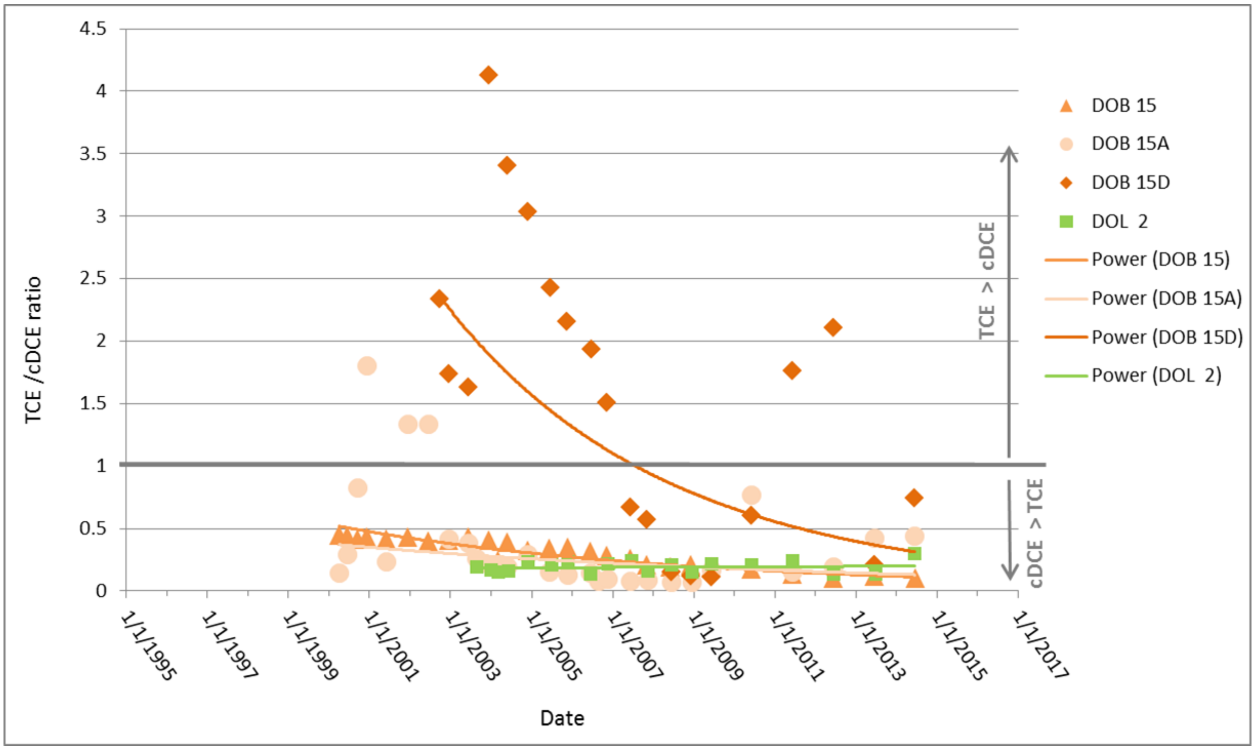



**Figure E-14. Ratio of PCE verses TCE Concentrations for Plume Compliance Wells (DOB 15, 15A, 15D, and DOL 2) and Additional Wells (DOB 11, 12, 13, 14) at the DOSB OU**



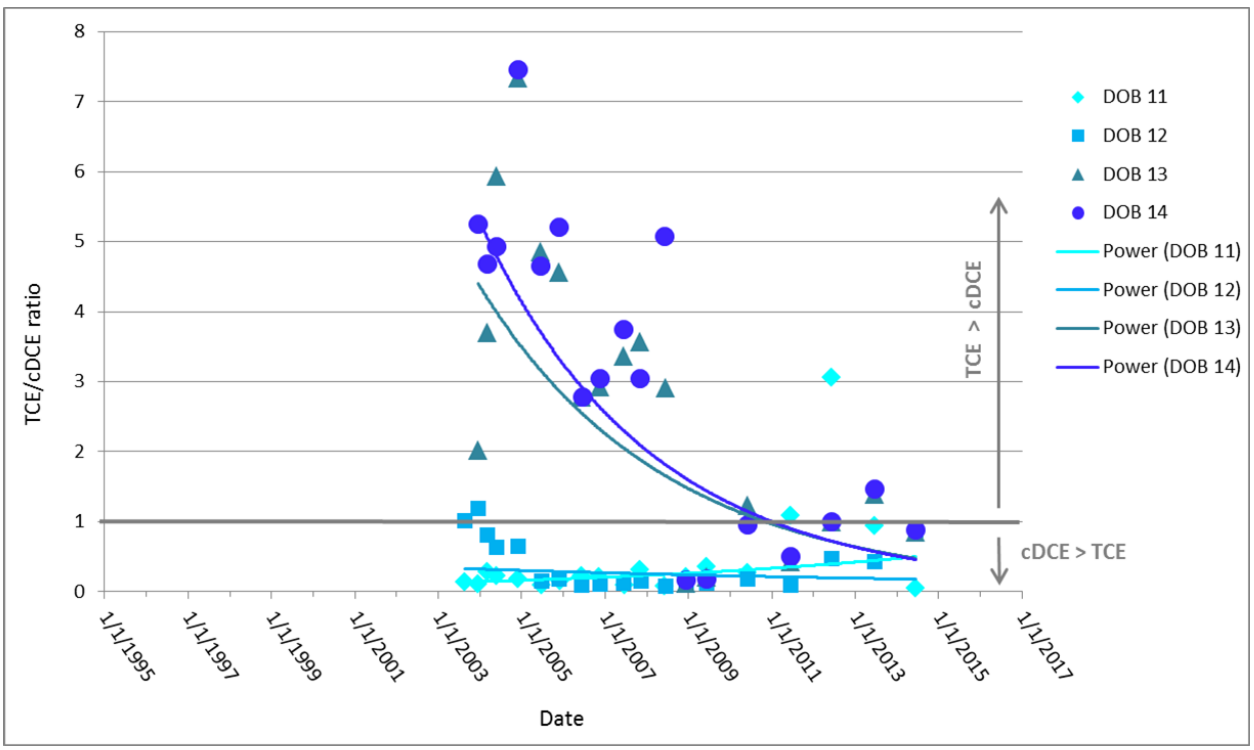




**Figure E-15. Ratio of TCE verses cDCE Concentrations for Plume Compliance Wells (DOB 15, 15A, 15D, and DOL 2) and Additional Wells (DOB 11, 12, 13, 14) at the DOSB OU**

**Table E-1. Chronology of OU Events**

| Event | Date |
|---|---|
| RFI/RI Field Start/Complete | 1995 / April 24, 1998 |
| Interim Record of Decision (ROD) Issuance | March 6, 1995 |
| Interim Remedial Action Start/Complete | August 13, 1996 / December 31, 1999 |
| Final ROD Signature | March 4, 1999 |
| Remedial Action Start/Complete | September 3, 1999/ January 13, 2000 |
| Previous Five-Year Reviews | June 30, 1997 / February 12, 2004 / February 4, 2009 / February 4, 2014 |

**Table E-2. Final COCs with Selected RGs**

| Final COCs | Maximum Concentration Detected (µg/L) | Average Concentration in Groundwater (1999-2015) (µg/L) | Selected RG (µg/L) |
|---|---|---|---|
| Tetrachloroethylene | 96 | 6.9 | 5.0 |
| Trichloroethylene | 255 | 15.2 | 5.0 |
| cis-1,2-Dichloroethene | 2,270 | 64.7 | 70.0 |
| 1,1-Dichloroethene | 4.8 | 0.8 | 7.0 |
| Vinyl chloride | 377 | 17.5 | 2.0 |
| Benzene | 7.8 | 0.7 | 5.0 |
| Dichloromethane | 1.7 | 0.9 | 5.0 |

**Table E-3. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs ($) | 60,124 | 42,551 | 29,687 | 83,842 | 216,204 |
| Total ROD Estimated Direct O&M Costs ($) | 29,466[1] | 12,800 | 12,800 | 12,800 | 67,866 |

[1]FY2012 estimated costs include costs associated with the fourth five-year remedy review.

**Table E-4. 2014 DOSB OU Natural Attenuation Field Parameters**

| Station | Well Use | Aquifer Zone | ORP | Dissolved Oxygen | pH | Total Alkalinity (AS $CaCO_3$) |
|---|---|---|---|---|---|---|
| | | | mV | mg/L | pH | mg/L |
| DOB 11 | Additional | AQ2 | -161 | 1.8 | 6.5 | 95 |
| DOB 12 | Additional | AQ2 | 103 | 4.34 | 5.3 | 9 |
| DOB 13 | Additional | AQ2 | 11 | 2.5 | 5.9 | 37 |
| DOB 14 | Additional | AQ2 | -91 | 1.4 | 5.8 | 38 |
| DOB 9 | Background Well | AQ1/2 | 106 | 6.01 | 4.9 | 0 |
| DOL 1 | Background Well | AQ3 | 229 | 3.2 | 4.7 | 0 |
| DOB 20 | Boundary Compliance | AQ3 | 190 | 3.48 | 6.9 | 69 |
| DOB 20A | Boundary Compliance | AQ1/2 | 232 | 3.53 | 4.8 | 0 |
| DOB 21 | Boundary Compliance | AQ3 | 8 | 3.26 | 6.8 | 71 |
| DOB 21A | Boundary Compliance | AQ1/2 | 245 | 4.34 | 4.9 | 0 |
| DOB 21PZ | Boundary Compliance | GAU | 136 | 2.09 | 5.2 | 1 |
| DOB 22 | Boundary Compliance | AQ3 | 237 | 2.91 | 5.8 | 25 |
| DOB 22A | Boundary Compliance | AQ1/2 | 244 | 3.12 | 4.8 | 0 |
| DOB 15 | Plume Compliance | AQ3 | 32 | 3.38 | 4.5 | 0 |
| DOB 15A | Plume Compliance | AQ2 | 307 | 2.28 | 4.8 | 0 |
| DOB 15D | Plume Compliance | GAU | 302 | 2.55 | 4.9 | 0 |
| DOB 15PZ | Plume Compliance | GAU | 270 | 2.18 | 4.6 | 0 |
| DOB 16 | Plume Compliance | AQ_Unnamed | -4 | 0.54 | 6.5 | 49 |
| DOB 19 | Plume Compliance | AQ3 | 70 | 2.9 | 6.5 | 20 |
| DOB 19A | Plume Compliance | AQ2 | 82 | 3.24 | 6.3 | 60 |
| DOB 23 | Plume Compliance | GAU | 224 | 4.19 | 5.4 | 9 |
| DOL 2 | Plume Compliance | AQ3 | 303 | 2.9 | 4.4 | 0 |

ORP = Oxidation/Reduction Potential
GAU = Gordon Aquifer Unit

**Table E-5. Issues Identified for DOSB**

| Issue | Currently Affects Protectiveness (Y/N) | Affects Future Protectiveness (Y/N) |
|---|---|---|
| 1,4-Dioxane has been identified as being a potential contaminant at DOSB based on its possible association with other solvents that are present at DOSB. However, there is a lack of groundwater data to dismiss 1,4-dioxane as being present at levels which would be harmful to human health or the environment. | N | N |

**Table E-6. Recommendations and Follow-up Actions for DOSB**

| Issue | Recommendations/ Follow-up Actions | Party Responsible | Oversight Agency | Milestone Date* | Affects Protectiveness? (Y/N) | |
|---|---|---|---|---|---|---|
| | | | | | Current | Future |
| 1,4-Dioxane has not been monitored recently in the DOSB wells. | 1,4-Dioxane will be monitored in all of the DOSB wells sampled for VOCs during the 2nd quarter 2016 sampling event. The data results will be presented in the 2016 DOSB Groundwater Report Letter that will be submitted in July 2017, as well as in the next Five-Year Remedy Review. Based on the results, the USEPA, SCDHEC and USDOE will decide whether 1,4-dioxane should be permanently added to the list of monitored constituents. | USDOE | SCDHEC/ USEPA | July 2017 | N | N |

## Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU

| I. SITE INFORMATION | | | |
|---|---|---|---|
| **Site Name:** | **D-Area Oil Seepage Basin (631-G) OU** | **Date of Inspection:** | **07/22/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS #27** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **Sunny 95°F** |

**Remedy Includes:** *(Click all that apply)*

- ☐ Landfill Cover/Containment
- ☐ Access Controls
- ☒ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☒ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☒ Other Groundwater Mixing Zone Monitoring

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

### II. INTERVIEWS *(Click all that apply)*

**1. O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 7/15/15 (Date)

**Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: (803)952-3324

**Problems/Suggestions:** ☐ Report Attached

**2. O&M Staff:** Richard Feagin (Name) EC&ACP Post-Closure Waste Site Inspector/Maintenance Coordinator (Title) 7/15/2015 (Date)

**Interviewed:** ☐ At Site ☐ At Office ☒ By Phone Phone No.:(803)-952-4416

**Problems/Suggestions:** ☐ Report Attached Only inspection requirement is monitoring well maintenance. Routine inspections are not required by the ROD or LUCIPs.

**Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)***

**II. INTERVIEWS** *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________

______________________

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☐ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Site Inspections for the surface unit portion of DOSB are not required by the ROD or LUCIP since the DOSB currently meets unrestricted land use criteria for soils, sediment and surface water. Site inspections performed are for the monitoring wells and the Five-Year Remedy Review Reports.

**Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)***

**III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)***

**2. Health and Safety Plans (HASPs):**

☐ Site-Specific Health and Safety Plans ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Contingency Plan/Emergency Response Plan ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER

**3. O&M and OSHA Training Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix

**4. Permits and Service Agreements:**

☐ Air Discharge Permit ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Effluent Discharge ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Waste Disposal; POTW ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Other Permits ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**5. Gas Generation Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**6. Settlement Monument Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**7. Groundwater Monitoring Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Annual Mixing Zone report and data is posted on ERDMS

**8. Leachate Extraction Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**9. Discharge Compliance Records:**

☐ Air ☐ Readily Available ☐ Up to Date ☒ N/A
☐ Water (Effluent) ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**10. Daily Access/Security Logs:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review

**Total annual cost by year for review period, if available**

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☒ Applicable ☐ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☐ N/A

Remarks: Gate and fencing around DOSB perimeter, although present, is not required. The fencing is a holdover from previous operations.

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☒ N/A

Remarks:

**Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)***

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walk-through
Frequency: Once every 5 years
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Karen Adams (Name) Federal Project Director (Title) 11/3/15 (Date) 803-952-7871 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

**2. Adequacy:** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks:

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)***

| VI. GENERAL SITE CONDITIONS |
|---|
| **A. Roads** ☒ Applicable ☐ N/A |
| **1. Roads damaged:** ☐ Location shown on site map ☒ Roads adequate ☐ N/A<br>Remarks:__________ |
| **B. Other Site Conditions** |
| Remarks:__________ |
| **VII. LANDFILL COVER/CONTAINMENT** ☐ Applicable ☒ N/A |
| **VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A |
| **IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A |
| **A. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **C. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **1. Pumps, Wellhead Plumbing, and Electrical:**<br>☐ Good Condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A<br>Remarks:__________ |
| **2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:**<br>☐ Good Condition ☐ Needs Maintenance<br>Remarks:__________ |
| **3. Spare Parts and Equipment:**<br>☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided<br>Remarks:__________ |
| **D. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **E. Treatment System** ☐ Applicable ☒ N/A |

**Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)***

| **IX. GROUNDWATER/SURFACE WATER REMEDIES *(Continued)*** |
|---|
| **F. Monitoring Data** ☒ Applicable ☐ N/A |
| **1. Monitoring Data:**<br>☒ Is routinely submitted on time ☒ Is of acceptable quality |
| **2. Monitoring Data:**<br>☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining |
| **G. Monitored Natural Attenuation** ☒ Applicable ☐ N/A |
| **1. Monitoring Wells** *(natural attenuation remedy)***:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition<br>☐ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks:_____________________________________________ |
| **X. OTHER REMEDIES** |
| If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. |
| **A. Soil Vapor Extraction System** ☐ Applicable ☒ N/A |
| **XI. OVERALL OBSERVATIONS** |
| **A. Implementation of the Remedy** |
| Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).<br><br>The DOSB OU deep soil is considered no further action since RAOs have been achieved by the IRA and bioventing testing. The remedy for shallow soil, surface water, and sediment is no action because no COCs in those media were identified in the RFI/RI Report and Baseline Risk Assessment Report. The remedy for DOSB OU groundwater is monitored natural attenuation/groundwater mixing zone with institutional controls. Results from the bioventing study indicate that the source of groundwater contamination (i.e., contaminants in the DOSB OU soil) was significantly reduced, as a result of the combined IRA and bioventing test, and no longer contributes to groundwater contamination. |

## Attachment E-1. Five-Year Review Site Inspection Checklist – D-Area Oil Seepage Basin (631-G) OU *(continued)*

| XII. OVERALL OBSERVATIONS *(Continued)* |
|---|
| **B. Adequacy of O&M** |
| Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.<br><br>Monitoring data appears to be consistent with the modeling predictions from the GWMZ application. The concentrations should continue to decrease within the heart of the plume through natural attenuation to levels at or below MCLs. Based on the monitoring data collected to date, the remedy is functioning as intended in the final ROD. Therefore, the mixing zone is protective of human health and the environment and is expected to remain protective for the future. |
| **C. Early Indicators of Potential Remedy Failure** |
| Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.<br><br>N/A |
| **D. Opportunities for Optimization** |
| Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.<br><br>N/A |

***End of Checklist***

## L-AREA BURNING/ RUBBLE PIT (131-L), GAS CYLINDER DISPOSAL FACILITY (131-2L), AND L-AREA RUBBLE PILE (131-3L) OPERABLE UNIT

### I. Introduction

This report is the third five-year review for the L-Area Burning/ Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) (LBRP/GCDF/LRP) Operable Unit (OU). The review was conducted from August 2015 through November 2015. Contaminants have been left in place at the LBRP/GCDF/LRP OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the LBRP OU is protective of human health and the environment. This report documents the results of the review.

### II. OU Chronology

Table F-1 lists the chronology of site events for the LBRP/GCDF/LRP OU.

### III. Background

The LBRP/GCDF/LRP OU is a Resource Conservation Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) (FFA 1993) for Savannah River Site (SRS). The media associated with this OU are soil and groundwater.

The scope of the LBRP/GCDF/LRP OU remedial action includes five subunits: (1) LBRP, (2) GCDF, (3) LRP, (4) LRP Ditch, and (5) groundwater (Figure F-2).

#### Physical Characteristics

The LBRP/GCDF/LRP OU is located in the interior of SRS approximately 6 miles from the nearest SRS boundary (Figure F-1) and is close to the industrially developed L-Reactor Area, one of several inactive nuclear reactor areas at SRS. LBRP/GCDF/LRP is approximately 396 m (1,320 ft) northwest of L-Reactor Area.

The LBRP/GCDF/LRP OU is comprised of five subunits (Figure F-2):

- LBRP was a single burning/rubble pit (trench), approximately 69 m x 8.7 m x 3 m (230 ft x 29 ft x 10 ft) deep.
- The GCDF is an area 4.2 m (14 ft) wide by 8.1 m (27 ft) long, located on the southwest corner of the LBRP, where gas cylinders were placed and vented;
- LRP is an area of rubble piles located north of the LBRP. The topography slopes gently (3 percent grade) to the north-northwest toward LRP Ditch. LRP is approximately 150 m (500 ft) long by 36 m (120 ft) wide.
- LRP Ditch is approximately 1.5 m (5 ft) wide and 0.9 m (3 ft) deep and is a natural drainage ditch north of the rubble piles. The LRP Ditch in the vicinity of LRP is generally dry. Approximately 420 m (1,400 ft) downgradient of LRP (based on 2012 data), LRP Ditch intersects the water table and is a perennial stream below that point.
- Groundwater - The depth to groundwater is approximately 12 m (40 ft) in this area.

**Land and Resource Use**

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999a) designates the LBRP/GCDF/LRP OU as being within the site industrial support area. The future land use for the LBRP/ GCDF/LRP OU is reasonably anticipated to remain industrial with the U.S Department of Energy (USDOE) maintaining control of the land.

**History of Contamination**

LBRP was used from 1951 to 1973 for periodic burning of combustible wastes (Figure F-3) . Information obtained from historical records and from characterization of similar burning/rubble pits at SRS indicates that materials such as wood, cardboard, paper, plastics, rubber, rags, waste oils, degreasers, and organic liquids of unknown use and origin were disposed in the pit and burned on a monthly basis. Waste burning was discontinued in 1973, and a soil layer was placed over the pit contents. The pit continued to receive non-salvageable wastes such as lumber, wood, concrete, scrap metal, cable, electrical wiring, zinc-mercury and lead-acid batteries, non-returnable empty drums, wallboard, brick, asphalt, tile, cans and bottles, rubber and plastic items, a transformer that did not contain polychlorinated biphenyls (PCBs), and other debris. Historical records indicate that LBRP was the only rubble pit at SRS to receive batteries. When the pit reached capacity in 1978, it was filled to grade with clean soil. In April 1998, exploratory trenching identified numerous zinc-mercury and lead-acid batteries and other debris in the northwest end of the pit.

The GCDF was used into the 1970s as a location for venting gas cylinders. Records indicate that 28 gas cylinders containing hazardous gases had been placed in GCDF in 1977.

LRP originally consisted of 15 rubble and soil piles randomly scattered throughout the area. The disposal history is largely unknown. Based on the sizes and shapes of the rubble piles, disposal practices at LRP likely consisted of dumping truckloads of waste on the land surface.

No waste was placed in LRP Ditch. The ditch was assessed as part of this OU because it could have received stormwater runoff from LRP and, therefore, could have been contaminated.

Groundwater was assessed because it may have been impacted by leaching from one or more of the source units (i.e., LBRP, GCDF, and/or LRP).

**Initial Response**

In 1998, a time-critical removal action was implemented at LBRP with the primary objective of removing all principal threat source materials (PTSM) from the pit. Approximately 450 zinc-mercury batteries, 870 lead-acid batteries, a non-PCB transformer, and other miscellaneous debris were removed from the northwestern half of the pit. In addition to the batteries and pit debris, 0.3 to 0.6 m (1 to 2 ft) of soil was removed from the floor of the northwest end of the pit. The resulting final excavation was approximately 3.3 m (11 ft) deep and approximately 5.4 m (18 ft) wide at grade and 3 m (10 ft) wide at the bottom.

In 1997 at the GCDF, a time-critical removal action was performed with the primary objective of removing the gas cylinders. Visual inspection revealed puncture holes in the cylinders and confirmed that the cylinders were empty and that no PTSM (e.g., hazardous gases) remained inside. All of the cylinders, as well as concrete, asphalt, and approximately 0.3 m (1 ft) of soil from the footprint of the GCDF, were removed and dispositioned as non-hazardous solid waste.

In 1997, a time-critical removal action was performed at LRP to recover assorted cans, bottles, incandescent and fluorescent lights, light ballasts, railroad ties, electrical wiring, and scrap metal. Approximately 153 $m^3$ (200 $yd^3$) of non-hazardous waste (paper, plastic, metal, wood, etc.), 1.53 $m^3$ (2 $yd^3$) of hazardous waste (miscellaneous paint), and 36 $m^3$ (47 $yd^3$) of Toxic Substances Control Act (TSCA) waste (PCB-contaminated soil) were removed, transported, and disposed at CERCLA Off-Site-Rule-approved facilities. About 191 $m^3$ (250 $yd^3$) of soil and debris remained stockpiled at LRP.

**Basis for Taking Action**

The potential for exposure to or ingestion of contaminated soil and groundwater poses a potential increased risk of cancer to human receptors and is the basis for taking action at the LBRP/GCDF/LRP OU. The RFI/RI/BRA characterization identified contamination warranting remediation in two of the five subunits, the LRP, and groundwater (WSRC 2000a).

- LRP soil sampling after the 1997 removal action indicated there was contamination in the soil within the footprints of the original piles.
- Groundwater is contaminated by a small, diffuse plume of carbon tetrachloride ($CCl_4$). In addition, groundwater modeling indicates that the plume will not discharge to surface water at levels above maximum contaminant levels (MCLs) in the future. The plume is slowly moving to the west, with local groundwater flow toward Pen

Branch and the LRP Ditch (Figure F-2). Chloroform was recognized as a human health COC; however, groundwater concentrations are well below MCLs.

The three other subunits (LBRP, GCDF, and LRP ditch) required no further action.

- LBRP confirmatory sampling at the base of the excavation determined that no contaminated soil that represents a future residential human health risk > $1x10^{-6}$ remained. The excavation was backfilled with clean soil and returned to grade. No additional remedial actions (i.e., land use controls [LUCs] including signage or inspections were required for LBRP following the excavation.
- GCDF confirmatory soil samples collected from the excavation footprint after the time-critical removal action, confirmed that there were no problems warranting further action. The excavated area was backfilled to grade with clean soil in July 1998.
- LRP Ditch sample results demonstrate that it has not been impacted by the OU. No constituents warranting remedial action (refined constituents of concern [RCOCs]) were identified.

## IV. Remedial Actions

### Remedy Selection

As stated in the ROD (WSRC 2002), the selected remedy for the LBRP/GCDF/LRP OU is removal and disposal of contaminated soil and debris with institutional controls at the LRP contingent on confirmation sampling. The selected remedy for groundwater is a groundwater mixing zone (GWMZ) with institutional controls, monitoring, and periodic reporting until the MCL is attained for $CCl_4$ in all monitoring wells. The following remedial action objectives (RAOs) have been established for the LRP and groundwater:

***L-Area Rubble Pile***

- Prevent exposure of industrial workers to lead above minimum remedial goals (RGs); and

- Prevent exposure of ecological receptors to barium, cadmium, chromium, copper, lead, mercury, zinc, and Aroclor 1254 (PCB) above minimum RGs.

***Groundwater***

- Prevent human exposure to $CCl_4$ in groundwater above the MCL of 5.0 µg/L;
- Prevent or limit discharge of $CCl_4$ from groundwater to surface water at levels above the MCL of 5.0 µg/L; and
- Reduce $CCl_4$ concentrations in groundwater to below the MCL of 5.0 µg/L.

***Other Subunits***

No constituents of concern were determined for the LBRP, GCDF, and LRP Ditch. Therefore, no institutional controls or other remedial actions were selected for these subunits. Additionally, no RA or RAO for the surface water is required because the carbon tetrachloride plume in the groundwater is not impacting the surface water and is not expected to impact the surface water in the future (WSRC 2000b).

**Remedy Implementation**

The implementation of the selected remedy included the following activities:

***L-Area Rubble Pile***

- Performing a removal action that achieved residential RGs for the surface subunit. Approximately 1,550 $m^3$ (2,025 $yd^3$) of sanitary, hazardous, and PCB waste was removed and disposed of at approved disposal facilities.
- Collecting confirmatory soil samples and verifying that residential RGs have been met (WSRC 2004).
- Backfilling, grading, and seeding excavated areas using the surrounding soil in the waste unit.

Per the ROD, institutional controls (i.e., LUCs) at LRP were contingent upon confirmation sampling. As documented in the Post Construction Report (PCR) (WSRC 2004), the removal and disposal action performed at the LRP achieved residential RGs and no LUCs including signage and inspections are required. In addition, the removal action was successful in achieving ecological RGs.

***Groundwater***

- Establishing a groundwater monitoring network which includes plume and compliance boundary wells in accordance with the approved Groundwater Mixing Zone Application (GMZA). The individual wells that are used in the monitoring network are described in the Post Construction Report (WSRC 2004).

- Implementing LUCs (i.e., institutional controls) for the groundwater plume to prevent use of the groundwater as a drinking water source at least until the MCL is attained in all monitoring wells. This consists of general site access controls (gates, fences, and patrol at the site boundary), groundwater use restrictions, the SRS Site Use/Site Clearance program, and future deed restrictions and notifications to prevent exposure of human health receptors to contaminated groundwater if property is transferred to non-federal ownership.

**System Operations/Operation and Maintenance**

There are no system operational requirements.

The following maintenance activities are ongoing:

- Sampling of the GWMZ monitoring wells. The monitoring program verifies the natural decrease of contaminant concentrations in the groundwater to levels below MCLs for $CCl_4$. Sampling will continue until the MCL of 5.0 µg/L has been attained, the RAO has been achieved, and the remedial action is complete. The results have been reported via annual Effectiveness Monitoring Reports since 2004. Starting in 2008, the monitoring results for LBRP/LRP OU were combined with the KBRP/KRP OU and PBRP OU monitoring reports into a single abbreviated annual groundwater data summary, with full detailed reports every five years (WSRC 2008). The first five-year detailed report was submitted in June 2012 (SRNS 2012). Based on the prolonged stable conditions and lack of contamination in downgradient wells, sampling optimizations have been instituted which will reduce the number of wells sampled and also reduce the sampling frequency to annually (SRNS 2012). $CCl_4$ groundwater concentrations were originally expected to be below MCLs by 2004 due to the processes of advection and dispersion (WSRC 1999b). Although contamination still exists above MCLs, core concentrations continue to decline and a GWMZ is still reasonable for monitoring.

- LUCs are being enforced (preclude unauthorized access to the groundwater) (WSRC 2004) as long as groundwater concentrations exceed MCLs. LUCs are implemented by providing access controls to onsite workers via the Site Use Program/Site Clearance Program, protecting authorized monitoring well workers via worker training and work control procedures, and providing access controls against trespassers at the SRS boundary.

Operation and maintenance (O&M) costs associated with the selected remedy for the LBRP, LRP, and GCDF OU include institutional controls and groundwater mixing zone monitoring and reporting. The ROD estimated O&M cost associated with the selected remedy has a present worth of $70,000 discounted at 7% per year for 30 years of maintenance activities. The ROD did not estimate O&M costs for groundwater monitoring. Estimated O&M costs from FY2012 through FY2015 are $27,000. The actual O&M cost from FY2012 through FY2015 is $56,569. The actual O&M costs (Table F-3) are higher than originally expected because groundwater monitoring and reporting costs were higher than estimated.

## V. Progress Since Last Review

The previous protectiveness statement concluded that because the remedial actions at LRP (removal/disposal) and the groundwater subunits (GWMZ with institutional controls) are protective, the site is protective of human health and the environment. The Removal/Disposal remedy is protective because no contamination above minimum RGs remains. The GWMZ remedy is protective because groundwater monitoring tracks the evolution of the plume as it naturally attenuates. Exposure pathways that could result in unacceptable risks are controlled by the LUCs.

Based on the prolonged stable conditions and lack of contamination in downgradient wells, sampling optimizations were instituted in 2013 which reduced the number of wells sampled and also reduced the sampling frequency to annually (SRNS 2012).

There were no recommendations or follow-up actions from the last five-year review.

## VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Reviewed existing groundwater data (Table F-4);
- Confirmed implementation of the remedial action;
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist, provided in Attachment F-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

***Data Review***

Annual groundwater reports or data summaries have been submitted for the LBRP/GCDF/LRP OU since 2004 and were thoroughly reviewed for this Five-Year Remedy Review. The latest 2014 letter data summary report includes a time-series plot of $CCl_4$ at well LRP 6R, a plume map, and a summary of the monitoring activities and monitoring results (USDOE 2015).

***Summary of Inspections and Interviews***

Interviews were conducted with Richard Feagin, O&M staff member, and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The LBRP/GCDF/LRP OU was inspected by SRNS and USDOE personnel on July 21, 2015 and October 26, 2015. No issues were identified for the LBRP/GCDF/LRP OU during this inspection and interviews.

## VII. Technical Assessment

**Is the Remedy Functioning as Intended by the Decision Document?**

The remedy is functioning as intended as demonstrated below:

- The Removal/Disposal remedy for the LRP is effective in preventing industrial workers and ecological receptors exposure to hazardous contamination. The removal and disposal of contaminated soils has reduced soil contaminant levels to below residential levels. Per the ROD, no LUCs are necessary for the LRP, therefore, no access control warning signs are installed at this OU. Confirmation soil sample concentrations compared to RGs are provided in Table F-5.

- The GWMZ with LUCs is effective in preventing human exposure to groundwater concentrations of $CCl_4$ above MCLs, and in preventing the discharge of $CCl_4$ to surface water above MCLs. The seepline samples from a nearby stream continue to be non-detect (Table F-4).

- The in situ treatment through natural processes using a GWMZ with LUCs is effective for reducing $CCl_4$ concentrations to below MCLs. Monitoring of the groundwater plume verifies that the contaminant concentrations are decreasing, consistent with cleanup objectives. A time-series plot of $CCl_4$ at the plume wells LRP 6R and LRP 7D are provided in Figure F-5.

This remedy was selected because existing groundwater data and modeling indicate the plume is small and diffuse and is expected to attenuate below MCLs within five years (by approximately 2004). However, concentrations remained above the MCL of 5 µg/L longer than expected, but were well below the Mixing Zone Concentration Limits (MZCLs) of 13 µg/L. Concentrations have displayed a declining trend over the last nine years and have been below the MCL the previous 2 years (Figure F-5). Results from 2014 were at a maximum of 2.2 µg/L in one well, LRP 6R (Figure F-2). The optimized compliance monitoring well, LRP 7D, was non-detect for carbon tetrachloride. All other monitored constituents (chloroform, chloromethane, and dichloromethane) were either non-detect or below MCLs in 4Q14. Based on 2014 monitoring data (Table F-4), the requirements of the GWMZ continue to be satisfied.

The Land Use Control Implementation Plan is included as Appendix A in the PCR and governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2004). The remedy is meeting the LUC objective to prevent access or use of contaminated groundwater until cleanup levels are achieved.

**Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?**

The exposure assumptions and toxicity data used at the time of remedy selection are still valid. No changes in MCLs have occurred since the last five-year remedy review in 2012 for the currently monitored RCOCs as shown in Appendix B. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No other information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

There are no issues related to current site conditions that prevent the remedy from being protective.

## IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for the LBRP/GCDF/LRP OU.

## X. Protectiveness Statement(s)

The remedy at LBRP/GCDF/LRP OU is protective of human health and the environment.

All threats to contaminated soil at the LRP subunit were addressed through the removal/disposal of contaminated soils and confirmation sampling that residential cleanup values were achieved. Groundwater exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated groundwater. LUCs include access controls to onsite workers via the Site Use Program/Site Clearance Program, protecting authorized monitoring well workers via worker training and work control procedures, and providing access controls against trespassers at the SRS boundary.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater Remedies is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2012. *K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G)(KBRP), L-Area Burning/Rubble Pit and Rubble Pile (131-L, 131-3L, and 131-2L)(LBRP), and P-Area Burning/Rubble Pit (131-P)(PBRP) Operable Units (OUs) Detailed Combined Groundwater Monitoring Report (U)*, SRNS-RP-2012-00200, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999a. *Land Use Control Assurance Plan for the Savannah River Site,* WSRC-RP-98-4125, Revision 1.1, March 2013, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 2015. 2014 *K-Area Burning/Rubble Pit and Rubble Pile (131-K and 631-20G) (KBRP), L-Area Burning/Rubble Pit and Rubble Pile (131-L, 131-3L, and 131-2L)*

*(LBRP), and P-Area Burning/Rubble Pit (131-P)(PBRP) Operable Units Combined Groundwater Monitoring Report (Sampling Summary), CERCLIS Numbers: 40, 56, and 59*, IACD-15-155, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken SC

WSRC, 1999b. *Groundwater Flow and Transport Modeling for the L-Area Burning/Rubble Pit (131-L), L-Area Rubble Pile (131-3L), and L-Area Gas Cylinder Disposal Facility (131-2L) Savannah River Site, Aiken, South Carolina (U)*, WSRC-RP-99-4154, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2000a. *RCRA Facility Investigation/ Remedial Investigation Report with Baseline Risk Assessment for the L-Area Burning Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) (U)*, WSRC-RP-98-4076, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2000b. *Groundwater Mixing Zone Application for the L-Area Burning Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) Operable Unit Savannah River Site, Aiken South Carolina (U)*, WSRC-RP-2000-4139, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2002. *Record of Decision Remedial Alternative Selection for the L-Area Burning/ Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) (U)*, WSRC-RP-98-4195, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2004. *Post-Construction Report for the L-Area Burning/ Rubble Pit (131-L), Gas Cylinder Disposal Facility (131-2L), and L-Area Rubble Pile (131-3L) including the Land Use Control Implementation Plan (Appendix A) (U)*, WSRC-RP-2003-4126, Revision 1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Proposal to Standardize Sampling and Reporting Requirements of Groundwater Data for P, L, and K Area Burning/Rubble Pit Operable Units*, ACP-08-133, Revision 0, Washington Savannah River Company, Savannah River Site, Aiken, SC

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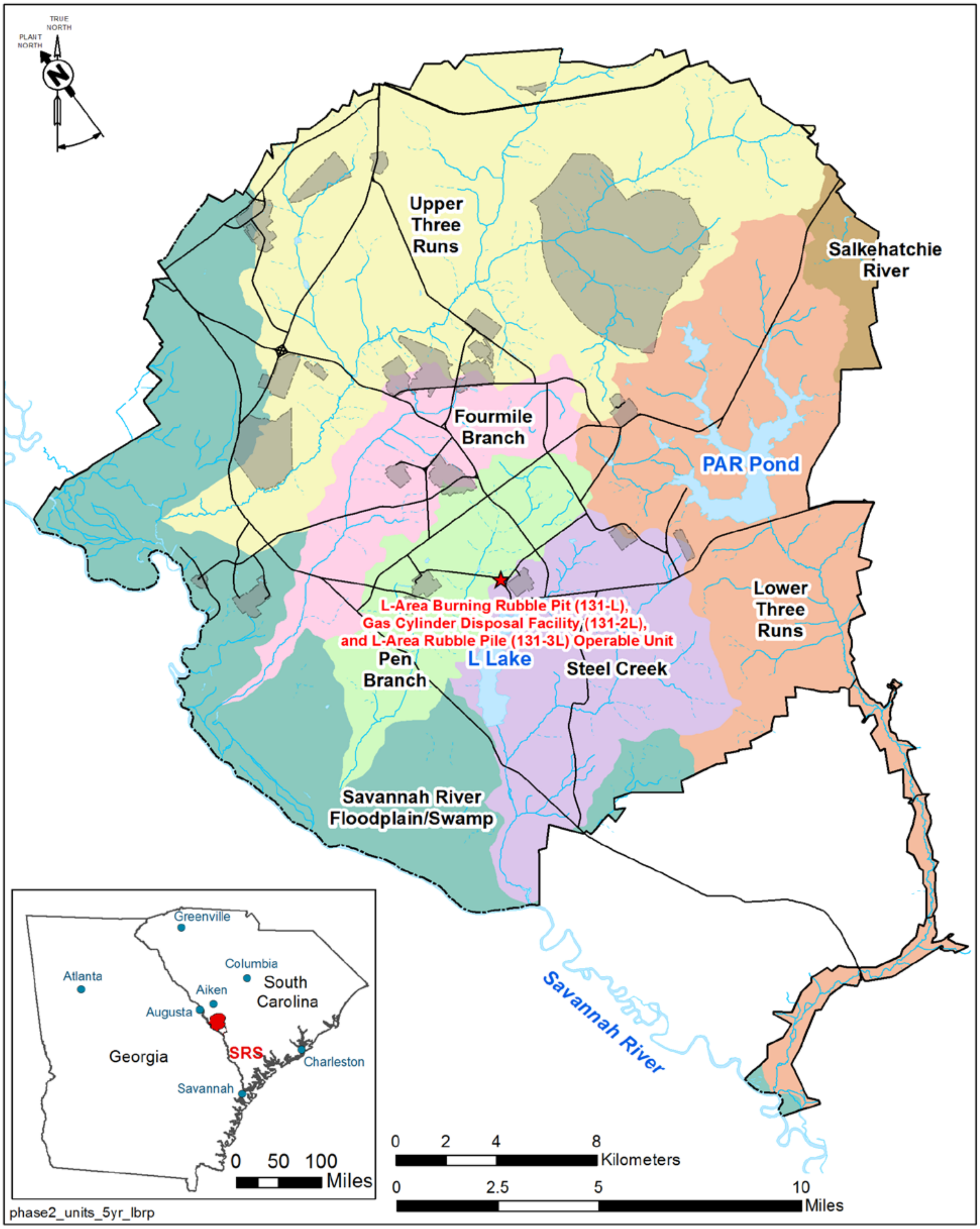


**Figure F-1. Location of the LBRP, GCDF, and LRP OU within SRS**

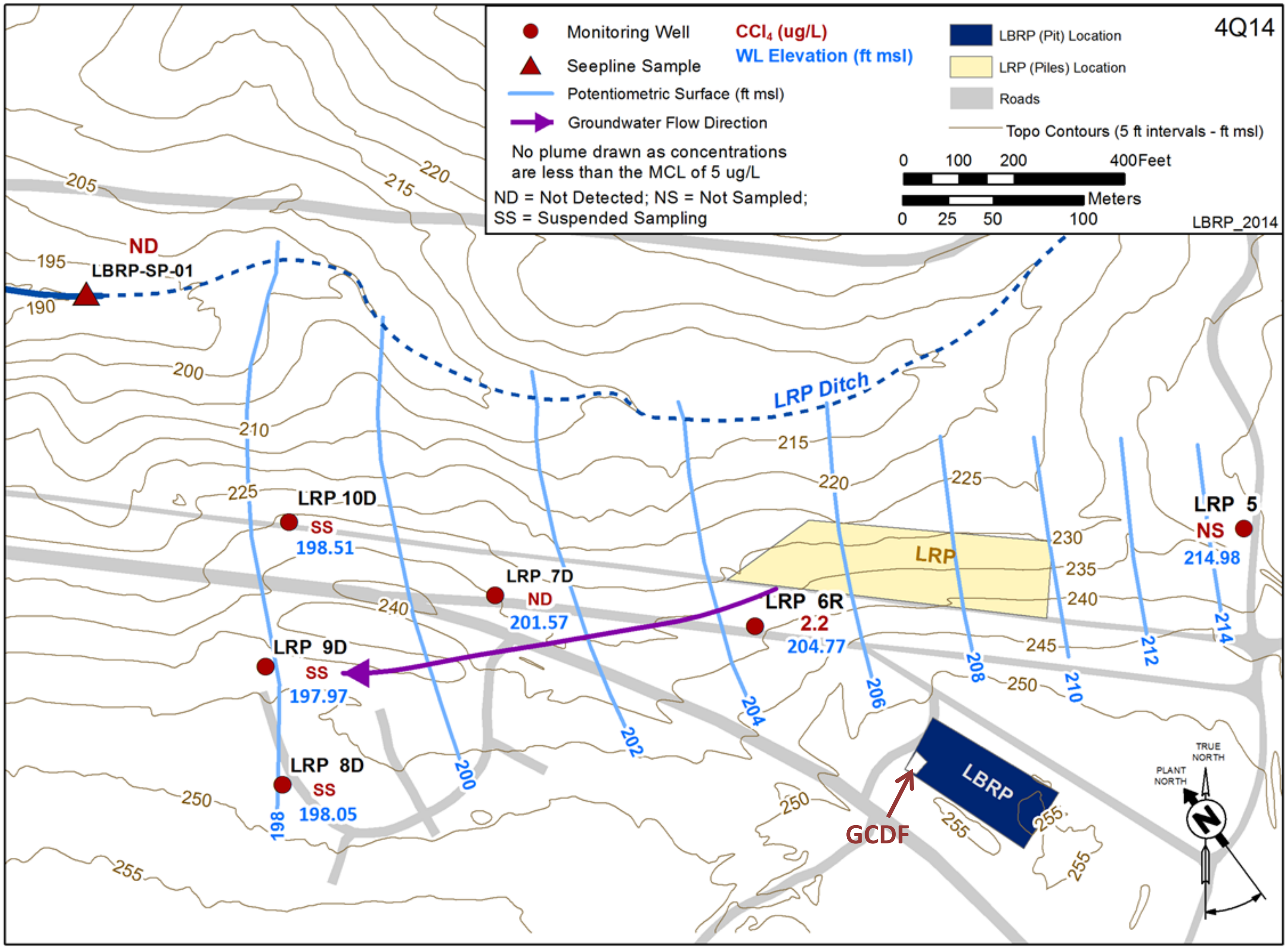


Figure F-2. LBRP, GCDF, LRP, Monitoring Wells, $CCl_4$ Plume Location, and Water Table Surface

**Figure F-3. Photo of LBRP During Disposal Activities (Mid 1970's)**

**Figure F-4. Photo of LBRP Currently (2015)**

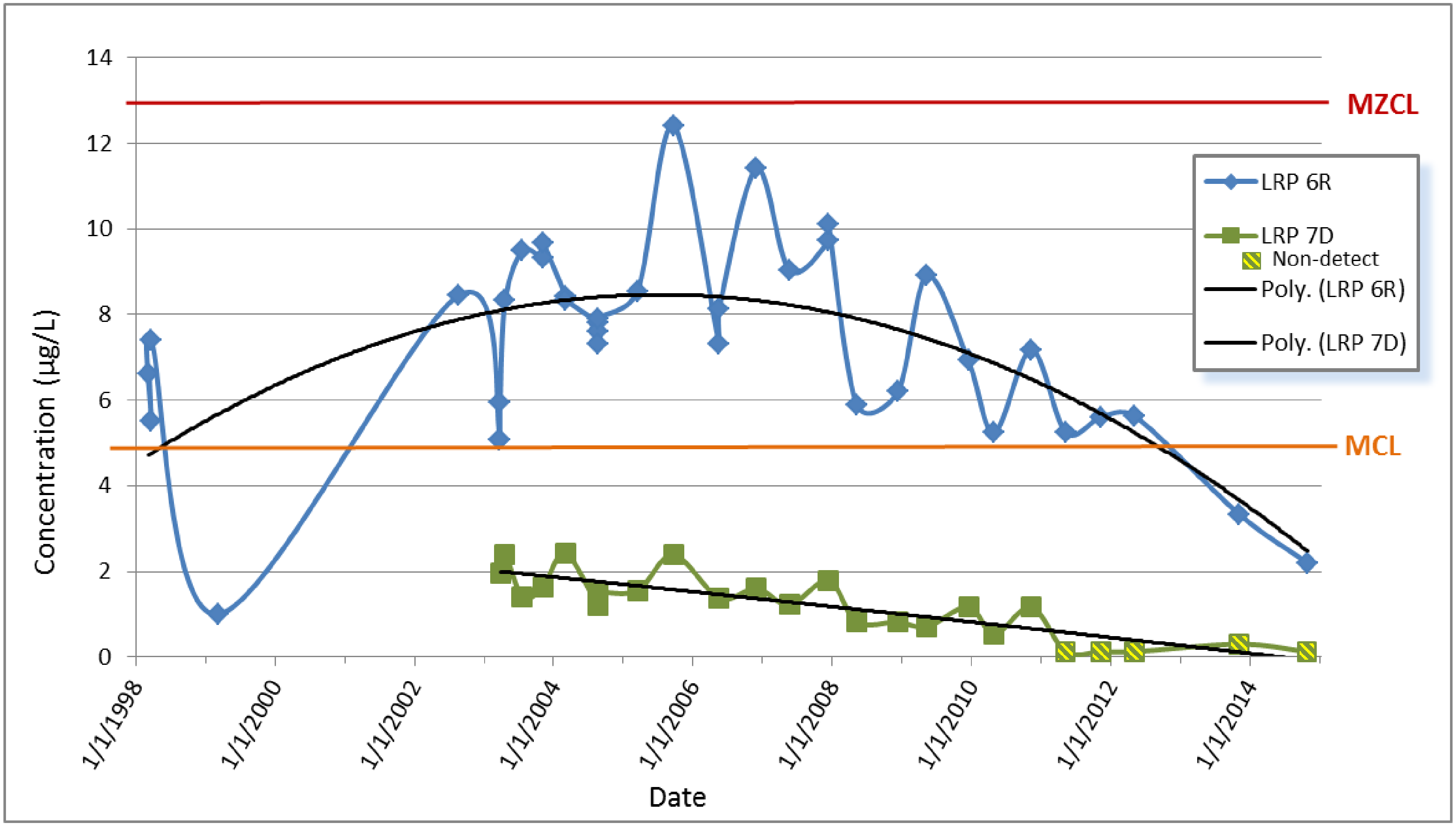


**Figure F- 5.** **Time Series Plot of $CCl_4$ at Plume Well LRP 6R and Compliance Well LRP 7D**

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**Table F-1. Chronology of OU Events**

| Event | Date |
|---|---|
| RFI/RI Start/Complete | October 31, 1997/October 5, 2000 |
| Time Critical Removal Action Start / Complete | 1997 / 1998 |
| Record of Decision (ROD) Issuance | January 10, 2003 |
| Remedial Action Start/Complete | April 15, 2003 / March 6, 2004 |
| Previous Five-Year Review | February 4, 2009 / February 4, 2014 |

**Table F-2. RCOCs and RGs for the Future Industrial Worker**

| Subunit | Medium | RCOC | Type | RG |
|---|---|---|---|---|
| LBRP | Soil | none | none | none |
| GCDF | Soil | none | none | none |
| LRP Ditch | Soil/Sediment | none | none | none |
| LRP◊ | Soil | Barium | ECO | 235 mg/kg |
| | | Cadmium | ECO, HH | 1.73 mg/kg |
| | | Copper | ECO | 60 mg/kg |
| | | Lead | ECO, HH ARAR | 500 mg/kg |
| | | Mercury | ECO, HH | 3.54 mg/kg |
| | | Zinc | ECO | 107 mg/kg |
| | | Aroclor 1254 (PCB) | ECO, HH | 0.219 mg/kg |
| Groundwater | Groundwater | Carbon tetrachloride | HH, ARAR | 5 µg/L |
| | | Chloroform | HH, ARAR | 80* µg/L |

ARAR Applicable or relevant and appropriate requirement RCOC
ECO Ecological RCOC
HH Human health RCOC
PCB Polychlorinated biphenyl
◊ In accordance with the ROD, chromium is not included as a RCOC for the industrial worker because the risk-based RG for chromium was less than background concentrations. Dibenzo[a,h]anthracene exceeded the residential RG but was not an RCOC for the future industrial worker and is therefore not included in this table.
* The MCL changed from 100 µg/L to 80 µg/L since issuance of the ROD.

**Table F-3. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs ($) | 19,011 | 17,686 | 3,486 | 14,665 | 54,848 |
| Total ROD Estimated Direct O&M Costs | 18,000[1] | 3,000 | 3,000 | 3,000 | 27,000 |

[1]FY2012 estimated costs include costs associated with the fourth five-year remedy review.

**Table F-4. Groundwater Monitoring Results Compared to MZCLs and MCLs**

| Station | Station Type | $CCl_4$ MZCL (µg/L) | MCL | | | |
|---|---|---|---|---|---|---|
| | | | 5 | 80 | 190* | 5 |
| | | | 4Q14 Results (µg/L) | | | |
| | | | $CCL_4$ | Chloroform | Chloromethane | Dichloromethane |
| LRP 6R | Plume | 13 | 2.2 | 2 | ND | ND |
| LRP 7D | Compliance | 5 | ND | 0.13 | ND | ND |
| LRP 8D | Compliance | 5 | SS | SS | SS | SS |
| LRP 9D | Compliance | 5 | SS | SS | SS | SS |
| LRP 10D | Compliance | 5 | SS | SS | SS | SS |
| LBRP-SP-01 | Seepline Surface Water | 5 | ND | ND | ND | ND |

*Chloromethane does not have an MCL, so the RSL Tapwater value is used
ND = Non-detect; SS = Suspended Sampling

**Table F-5. Confirmation Soil Sample Results Compared to RGs**

| Analyte (RCOC) | Max Result (mg/kg) | RG (mg/kg) | |
|---|---|---|---|
| | | Industrial Worker | Residential |
| Barium | 210 | 235 | 235 |
| Cadmium | 1.3 | 1.73 | 1.73 |
| Copper | 26.9 | 60 | 60 |
| Lead | 50.6 | 500 | 400 |
| Mercury | 0.4 | 3.54 | 0.748 |
| Zinc | 92.6 | 107 | 107 |
| Aroclor 1254 (PCB) | 0.11 | 0.219 | 0.141 |
| Dibenzo[a,h]anthracene | Non Detect | Not Applicable | 0.0613 |

## Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit

### I. SITE INFORMATION

| | | | |
|---|---|---|---|
| **Site Name:** | **L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit** | **Date of Inspection:** | **07/21/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS #31** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **92°F and clear** |

**Remedy Includes:** *(Click all that apply)*

- ☐ Landfill Cover/Containment
- ☒ Access Controls
- ☒ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☐ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☒ Other Groundwater Mixing Zone Application

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

### II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 07/15/2015 (Date)

   **Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

   **Problems/Suggestions:** ☐ Report Attached No issues identified.

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 07/15/2015 (Date)

   **Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

   **Problems/Suggestions:** ☐ Report Attached No issues identified.

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**II. INTERVIEWS *(Click all that apply)(Continued)***

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ______

**Contact:** ______ (Phone No.) (Name) (Title) (Date)

**Problems/Suggestions:** ☐ Report Attached No issues identified.

**Agency:** ______

**Contact:** ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______

**Agency:** ______

**Contact:** ______ (Name) ______ (Title) ______ (Date) ______ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______

4. **Other Interviews** *(Optional):* ☐ Report Attached

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Monitoring wells are inspected per ER-SOP-011, “ACP Monitoring Well Inspection (U)”

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Continued)*

**1. Health and Safety Plans (HASPs):**

| | | | |
|---|---|---|---|
| ☐ Site-Specific Health and Safety Plans | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Contingency Plan/Emergency Response Plan | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER

**2. O&M and OSHA Training Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

**3. Permits and Service Agreements:**

| | | | |
|---|---|---|---|
| ☐ Air Discharge Permit | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Effluent Discharge | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Waste Disposal; POTW | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Other Permits | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**4. Gas Generation Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**5. Settlement Monument Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**6. Groundwater Monitoring Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**7. Leachate Extraction Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**8. Discharge Compliance Records:**

| | | | |
|---|---|---|---|
| ☐ Air | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Water (Effluent) | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**9. Daily Access/Security Logs:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

**Total annual cost by year for review period, if available**

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☒ Applicable ☐ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks:

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☒ N/A
Remarks: Signs at this site are in good condition.

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS** *(Continued)*

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walk-throughs
Frequency: Annual
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) RCRA/Remedial Program Manager (Title) 10/26/15 (Date) 803-952-9333 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

**2. Adequacy:** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Survey orange balls are present and in good condition.

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

| VI. GENERAL SITE CONDITIONS |
|---|
| **A. Roads** ☒ Applicable ☐ N/A |
| **1. Roads damaged:** ☐ Location shown on site map ☒ Roads adequate ☐ N/A<br>Remarks:____ |
| **B. Other Site Conditions** |
| Remarks:____ |
| **VII. LANDFILL COVER/CONTAINMENT** ☐ Applicable ☒ N/A |
| **A. Landfill Surface** |
| **1. Settlement** (Low spots)**:** ☐ Location shown on site map ☐ Settlement not evident<br>Areal extent____ Depth____<br>Remarks:____ |
| **2. Cracks:** ☐ Location shown on site map ☐ Cracking not evident<br>Lengths____ Widths____ Depths____<br>Remarks:____ |
| **3. Erosion:** ☐ Location shown on site map ☐ Erosion not evident<br>Areal extent____ Depth____<br>Remarks:____ |
| **4. Holes:** ☐ Location shown on site map ☐ Holes not evident<br>Areal extent____ Depth____<br>Remarks:____ |
| **5. Vegetative Cover:** ☐ Grass ☐ Cover properly established ☐ No signs of stress<br>Areal extent____ Depth____<br>Remarks: Vegetation mowed routinely.____ |

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**VII. LANDFILL COVER/CONTAINMENT** *(Continued)*

**6. Alternative Cover (armored rock, concrete, etc.):** ☐ N/A
Remarks:______________________________

**7. Bulges:** ☐ Location shown on site map ☐ Bulges not evident
Areal extent__________ Depth__________
Remarks:______________________________

**8. Wet Areas / Water Damage:** ☐ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent__________
☐ Ponding ☐ Location shown on site map Areal extent__________
☐ Seeps ☐ Location shown on site map Areal extent__________
☐ Soft subgrade ☐ Location shown on site map Areal extent__________
Remarks:______________________________

**9. Slope Instability:** ☐ Slides ☐ Location shown on site map ☐ No evidence of slope instability
Areal extent__________
Remarks:______________________________

**B. Benches** ☐ Applicable ☐ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

**2. Flows Bypass Bench:** ☐ Location shown on site map ☐ N/A or okay
Remarks:______________________________

**3. Bench Breached:** ☐ Location shown on site map ☐ N/A or okay
Remarks:______________________________

**4. Bench Overtopped:** ☐ Location shown on site map ☐ N/A or okay
Remarks:______________________________

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**VII. LANDFILL COVER/CONTAINMENT** *(Continued)*

**C. Letdown Channels** ☐ Applicable ☐ N/A

(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

**1. Settlement:** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent__________ Depth__________
Remarks:______________________________________________________

**2. Material Degradation:** ☐ Location shown on site map ☐ No evidence of degradation
Material Type__________ Areal extent__________
Remarks:______________________________________________________

**3. Erosion:** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent__________ Depth__________
Remarks:______________________________________________________

**4. Undercutting:** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent__________ Depth__________
Remarks:______________________________________________________

**5. Obstructions:** Type__________ ☐ No obstructions
☐ Location shown on site map Areal extent__________ Size__________
Remarks:______________________________________________________

**6. Excessive Vegetative Growth:** Type__________
☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent__________
Remarks:______________________________________________________

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

| **VII. COVER SYSTEMS** *(Continued)* |
|---|
| **D. Cover Penetrations** ☐ Applicable ☐ N/A |
| **1. Gas Vents:** ☐ Active ☐ Passive<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A<br>Remarks:______________________ |
| **2. Gas Monitoring Probes:**<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A<br>Remarks:______________________ |
| **3. Monitoring Wells:**<br>☒ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A<br>Remarks:______________________ |
| **4. Leachate Extraction Wells:**<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A<br>Remarks:______________________ |
| **5. Settlement Monuments:** ☐ Located ☐ Routinely Surveyed ☐ N/A<br>Remarks:______________________ |
| **E. Gas Collection and Treatment** ☐ Applicable ☐ N/A |
| **1. Gas Treatment Facilities:**<br>☐ Flaring ☐ Thermal destruction ☐ Collection for reuse<br>☐ Good condition ☐ Needs maintenance<br>Remarks:______________________ |
| **2. Gas Collection Wells, Manifolds, and Piping:**<br>☐ Good condition ☐ Needs maintenance<br>Remarks:______________________ |

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

| **VII. COVER SYSTEMS** *(Continued)* |
|---|
| **3. Gas Monitoring Facility** *(e.g., gas monitoring of adjacent homes or buildings)***:**<br>☐ Good condition ☐ Needs maintenance ☐ N/A<br>Remarks:______ |
| **F. Cover Drainage Layer** ☐ Applicable ☐ N/A |
| **1. Outlet Pipes Inspected:** ☐ Functioning ☐ N/A<br>Remarks:______ |
| **2. Outlet Rock Inspected:** ☐ Functioning ☐ N/A<br>Remarks:______ |
| **G. Detention/Sedimentation Ponds** ☐ Applicable ☐ N/A |
| **1. Siltation:**<br>Areal extent______ Depth______ ☐ N/A<br>☐ Siltation not evident<br>Remarks:______ |
| **2. Erosion:**<br>Areal extent______ Depth______ ☐ N/A<br>☐ Erosion not evident<br>Remarks:______ |
| **3. Outlet Works:** ☐ Functioning ☐ N/A<br>Remarks:______ |
| **4. Dam:** ☐ Functioning ☐ N/A<br>Remarks:______ |
| **H. Retaining Walls** ☐ Applicable ☐ N/A |
| **1. Deformations:** ☐ Location shown on site map ☐ Deformation not evident<br>Horizontal displacement______ Vertical displacement______<br>Rotational displacement______<br>Remarks:______ |

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

| **VII. COVER SYSTEMS** *(Continued)* |
|---|
| **2. Deformations:** ☐ Location shown on site map ☐ Deformation not evident<br>Remarks:______________________________________________<br>______________________________________________ |
| **I. Perimeter Ditches/Offsite Discharge** ☐ Applicable ☐ N/A |
| **1. Siltation:** ☐ Location shown on site map ☐ Siltation not evident<br>Areal extent__________________ Depth____________________<br>Remarks:______________________________________________<br>______________________________________________ |
| **2. Vegetative Growth:** ☐ Location shown on site map ☐ N/A<br>☐ Vegetation does not impede flow<br>Areal extent____________________ Type_____________________<br>Remarks:______________________________________________<br>______________________________________________ |
| **3. Erosion:** ☐ Location shown on site map ☐ Erosion not evident<br>Areal extent__________________ Depth____________________<br>Remarks:______________________________________________<br>______________________________________________ |
| **4. Discharge Structure:** ☐ Location shown on site map ☐ N/A<br>Remarks:______________________________________________<br>______________________________________________ |
| **VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A |
| **1. Settlement:** ☐ Location shown on site map ☐ Settlement not evident<br>Areal extent__________________ Depth____________________<br>Remarks:______________________________________________<br>______________________________________________ |
| **2. Performance Monitoring:**<br>Type of Monitoring__________________________ ☐ Performance not monitored<br>Frequency_____________________ ☐ Evidence of breaching Head Differential__________________<br>Remarks:______________________________________________<br>______________________________________________ |

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A

**A. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A

**1. Pumps, Wellhead Plumbing, and Electrical:**
☐ Good Condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks:

**2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:**
☐ Good Condition ☐ Needs Maintenance
Remarks:

**3. Spare Parts and Equipment:**
☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

**B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A

**1. Collection Structures, Pumps, and Electrical:**
☐ Good Condition ☐ Needs Maintenance
Remarks:

**2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances:**
☐ Good Condition ☐ Needs Maintenance
Remarks:

**3. Spare Parts and Equipment:**
☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**IX. GROUNDWATER/SURFACE WATER REMEDIES** *(Continued)*

**C. Treatment System** ☐ Applicable ☒ N/A

**1. Treatment Train** (Check components that apply)**:**

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters__________
☐ Additive (e.g., chelation agent, flocculent)__________
☐ Others__________
☐ Good Condition ☐ Needs maintenance
☐ Sampling ports properly marked and function
☐ Sampling/maintenance log displayed and up-to-date
☐ Equipment properly identified
☐ Sampling ports properly marked and function
☐ Quantity of groundwater treatment annually__________
☐ Quantity of surface water treatment annually__________
Remarks:__________

**2. Electrical Enclosures and Panels** *(properly rated and function)***:**

☐ N/A ☐ Good Condition ☐ Needs maintenance
Remarks:__________

**3. Tanks, Vaults, Storage Vessels:**

☐ N/A ☐ Good Condition ☐ Proper secondary containment ☐ Needs maintenance
Remarks:__________

**4. Discharge Structure Appurtenances:**

☐ N/A ☐ Good Condition ☐ Needs maintenance
Remarks:__________

**5. Treatment Building(s):**

☐ N/A ☐ Good Condition (especially roof and doorways ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks:__________

**Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)***

**IX. GROUNDWATER/SURFACE WATER REMEDIES** *(Continued)*

**6. Monitoring Wells** *(pump and treatment remedy)***:**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:

**D. Monitoring Data** ☒ Applicable ☐ N/A

**1. Monitoring Data:**
☒ Is routinely submitted on time ☒ Is of acceptable quality

**2. Monitoring Data:**
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining

**E. Monitored Natural Attenuation** *(groundwater mixing zone application remedy*
☒Applicable ☐ N/A

**1. Monitoring Wells*)*:**
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs maintenance ☐ N/A
Remarks: All monitoring wells were inspected (LRP-5, LRP-6R, LRP-7D, LRP-8D, LRP-9D, LRP-10D). All well identification signs were in good condition.

**X. OTHER REMEDIES**

If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

**A. Soil Vapor Extraction System** ☐ Applicable ☒ N/A

**1. Blowers, Wellhead Plumbing, and Electrical:**
☐ Good Condition ☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks:

**2. Extraction System Pipelines, Valves, Valve Boxes and Other Appurtenances:**
☐ Good Condition ☐ Needs maintenance
Remarks:

**3. Spare Parts and Equipment:**
☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided
Remarks:

## Attachment F-1. Five-Year Review Site Inspection Checklist – L-Area Burning/Rubble Pit, Gas Cylinder Disposal Facility, and Rubble Pile Operable Unit *(continued)*

### XI. OVERALL OBSERVATIONS

**A. Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

Groundwater monitoring network of plume and boundary wells indicates the remedial action was successful. GMZA remains the best option for the contaminated groundwater as contaminant levels are decreasing, the plume is decreasing in size, and contaminant levels in a nearby stream are non-detect.

**B. Adequacy of O&M**

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The protectiveness of the completed remedial action is being monitored by continued groundwater sampling. The O&M procedures are effectively maintaining the monitoring wells. The wells are properly secured/locked, functioning and are in good condition. Institutional controls effectively prevent unauthorized access to the groundwater and include site access controls (gates, fences, and patrol at the site boundary), groundwater use restrictions, the SRS Site Use/Site Clearance program, and future deed restrictions and notifications to prevent exposure of human health receptors to contaminated groundwater if property is transferred to non-federal ownership.

**C. Early Indicators of Potential Remedy Failure**

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

**D. Opportunities for Optimization**

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

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## L-AREA SOUTHERN GROUNDWATER OPERABLE UNIT

## I. Introduction

This report is the third five-year review of the remedial actions implemented at the L-Area Southern Groundwater (LASG) Operable Unit (OU), which is located at the Savannah River Site (SRS). This report documents the results of the review conducted from August 2015 through November 2015. Contaminants have been left in place at the LASG OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the LASG OU is protective of human health and the environment.

## II. OU Chronology

Table G-1 lists the chronology of site events for the LASG OU.

## III. Background

The LASG OU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) (FFA 1993) for Savannah River Site (SRS). The media of concern is local groundwater. Surface water downgradient of the LASG OU is monitored to evaluate the effectiveness of the selected remedy.

As stated in the LASG OU Record of Decision (ROD), the scope of the LASG OU remedial action is limited to local groundwater in three known contaminated plumes, identified as a tritium plume west of the L-Area Reactor and two commingled volatile organic compound (VOC) and tritium plumes south of the L-Area Reactor (WSRC 2007a).

### Physical Characteristics

L Area is located in the south central portion of the SRS in Barnwell County, South Carolina (Figure G-1). LASG OU encompasses all of the groundwater from the L-Area groundwater divide south to L-Lake (Figure G-2). The original pre-work plan characterization outline for the LASG OU covered about 508 hectares (1,250 acres) and included several remediated/depleted source units, which supported past production activities (WSRC 2005). Groundwater characterization included the review of analytical data from 93 monitoring wells and 109 cone penetrometer technology (CPT) locations within the LASG OU (Figure G-3) between January 2000 and January 2004. The majority of the sampling occurred in 2000.

Operation activities in L Area have resulted in three contaminant plumes in the local groundwater:

- Western tritium plume, which originated at the L-Area Emergency Retention Basin (LAERB);
- Southwest commingled VOCs and tritium plume, which originated in the vicinity of the L-Area Disassembly Basin (LADB); and
- Southeast commingled VOCs and tritium plume, with likely sources from the L-Area Reactor Seepage Basin (LRSB), L-Area Oil and Chemical Basin (LAOCB), and L-Area Hot Shop (LAHS).

There are no active sources of groundwater contamination in the LASG OU. Historical sources have been remediated, depleted, or reconditioned for new missions.

**Land and Resource Use**

The land use control boundaries for LASG OU are predominantly outside of the industrial area for L-Area. However, shallow groundwater and surface water at SRS are not used for drinking water, hygiene, recreation, or process water. According to the Savannah River Site Future Use Project Report (USDOE 1996), residential uses of the SRS land should be prohibited. The future land use for this OU is reasonably anticipated to be industrial with the U.S Department of Energy (USDOE) maintaining control of the land.

### History of Contamination

The L-Area Reactor achieved criticality in August 1954 and operated from 1954 to 1968 and 1984 to 1988. Tritium was produced in the reactor and VOCs were used as solvents and degreasers. Past activities at or near these source units listed above (LAERB, LADB, LRSB, LAOCB, and LAHS) have resulted in groundwater contamination in LASG OU. The tritium and VOC plumes are shown in Figure G-2.

The primary historical sources of contamination in the groundwater in the LASG OU have been remediated or depleted. Subsurface soils beneath these remediated waste sites were the secondary sources of groundwater contamination. The contamination history of the source units are discussed below:

- The LAERB is no longer active and was never used as designed; however, tritiated water was released to the basin during testing in the 1980s. Rainwater flushed the original tritium source out of the unit into the groundwater through the permeable bottom of the basin.
- Groundwater in the vicinity of the LADB was previously contaminated by leaks and spills associated with previous operations. Upgrades to equipment and handling processes support its current mission as an active facility. Current data indicate the LADB is not an active source of groundwater contamination as tritium concentrations in adjacent wells have dramatically decreased from historical values. The LADB is being monitored for any new releases related to its new mission under a separate program.
- The LRSB is a L-shaped unlined earthen basin that was designed to hold contaminated wastewater from L-Area reactor operations that was not appropriate for discharge to local streams due to elevated radiological activity. Discharges to the LRSB were conducted from 1958 to 1968 and from 1985 to 1988. Contaminated soils posed a potential contaminant migration concern to groundwater. Contaminated soils and pipelines were consolidated in the basins and a low permeability soil cover was installed to reduce water infiltration while natural radioactive decay reduces the contaminant levels.

- The LAHS was primarily used for repairing equipment from the reactor areas, which may have been contaminated with radionuclides. Radionuclides deposited on the concrete floors of the LAHS buildings and the associated storage facilities and in the drainlines appear to be the primary source material. Remediation was completed in 2005, which consisted of the removal of contaminated drainlines, concrete floor slabs, and soils. Clean topsoil and vegetation were placed in the area.

- The LAOCB was constructed in 1961 as an unlined seepage basin to receive wastewater from the LAHS. The LAHS discharged decontamination wastewater containing radionuclides, detergents, and spent degreasing solvents through the pipeline to the basin. It also received wastewater from other areas of SRS that were transported in drums and tanker trucks, which included liquid wastes consisting of small volumes of slightly radioactive oil and chemical wastewater. The LAOCB remained active until 1979. Remediation of the LAOCB was completed in 2001 and included consolidation of contaminated material, in-situ stabilization by grouting soil, and installation of a low permeability soil cover system.

**Initial Response**

There was no initial response for the LASG OU. There are no active sources of groundwater contamination in the LASG OU. Historical sources have been remediated, depleted, or reconditioned for new missions.

**Basis for Taking Action**

The potential exposure to or ingestion of groundwater and surface water contaminated above MCLs poses a potential increased risk of cancer to human receptors and is the basis for taking action at the LASG OU.

The refined constituents of concern (RCOCs) for groundwater at LASG OU are tritium, tetrachloroethylene (PCE), and trichloroethylene (TCE). The highest contaminant levels observed in local groundwater, broken into four groups (Pre- remedial investigation [RI], RI, Post-RI - 2013, present), are summarized in Table G-2; CPT data are included in the pre-RI data set and contain high tritium values that are not seen in the monitoring well network, therefore, the pre-RI and RI tritium concentrations vary significantly. The remedial goals (RGs) for LASG OU are the MCLs as listed in Table G-2.

The bulk of contaminated groundwater is confined to the portion of the Upper Three Runs aquifer above the tan clay. Figure G-2 shows the LASG OU plumes. The western plume is only contaminated with tritium while the two plumes directly downgradient southwest and southeast of L Area are contaminated with tritium, PCE, and TCE. The analytical results for these three constituents are summarized in Table G-2. Surface water sample stations are shown on Figure G-2 and the results for tritium at these stations are listed in Table G-3; SC26 and SC27 are at the L-Lake dam standpipe and spillway, respectively. PCE and TCE have not been detected in the surface water, except once in 2010 at station SC24, but at low levels below 1 µg/L.

Exposure of future industrial workers and/or residents to TCE, PCE, and tritium in groundwater above their respective MCLs could increase the risk of cancer. If land use controls (LUCs) are not maintained, exposure could occur through ingestion, dermal contact, and inhalation of contaminated groundwater. Groundwater contamination was evaluated against MCLs based on South Carolina Department of Health and Environmental Control (SCDHEC) groundwater regulation R.61-58.5, which is protective for both future residential and future industrial scenarios.

## IV. Remedial Actions

### Remedy Selection

As stated in the ROD (WSRC 2007a), the selected remedy for the LASG OU is monitored natural attenuation (MNA) with institutional controls (i.e., LUCs). The selected remedial action for the LASG OU will address both of the commingled VOCs and tritium plumes of L Area and the tritium plume west of L Area. LUCs will minimize the potential for human exposure to contaminated groundwater until MCLs are achieved.

The following remedial action objectives (RAOs) have been identified for the LASG OU:

- Prevent human exposure to groundwater above MCLs.

- Treat and/or mitigate groundwater contaminated above MCLs to reduce the discharge of groundwater exceeding MCLs to L-Lake.

These RAOs are intended to protect current workers and future industrial workers, minimize the impact of groundwater discharging to surface water, and return groundwater to usable conditions. The RGs for the LASG OU contaminants of concern are the MCLs.

**Remedy Implementation**

The remedial action is meeting the RAOs, by implementing the following activities:

- Established a groundwater monitoring network by installing ten new monitoring wells (WSRC 2007b).

- Established a MNA program to monitor natural attenuation processes (dispersion, dilution, and radioactive decay) which are occurring at the LASG OU and are effective in reducing contaminant concentrations below remedial goals. Twenty-six groundwater monitoring wells and five surface water monitoring stations (Figure G-2) make up the monitoring network. Details of the requirements for MNA monitoring at the LASG OU are presented in the Effectiveness Monitoring Plan (EMP) (WSRC 2008) and the subsequent addendum to the EMP (SRNS 2013).

- There are no active, continuing sources of groundwater contamination at the LASG OU. As stated in the EMP, one of the groundwater monitoring data quality objectives is ensuring that there are no releases of contaminants from unknown or existing sources and that remediated or depleted sources are under control. The ROD or post-ROD documents for LRSB (WSRC 2002) and LAOCB (WSRC 1999) both required that evaluation of the effectiveness of those remedies would be addressed through monitoring implemented as part of the LASG OU.

- Established land use controls for 387 hectares (952 acres), which includes implementing LUCs at LASG OU. This consists of general site access controls (gates, fences, and patrol at the site boundary), use restrictions via the SRS Site

Use/Site Clearance program, and future deed restrictions and notifications to prevent exposure of human receptors to contaminated groundwater if property is transferred to non-federal ownership.

**System Operations/Operation and Maintenance**

There are no system operational requirements.

The following maintenance activities are ongoing:

- Long-term monitoring of groundwater conditions in the plumes and surface water conditions in L-Lake, including maintenance of the monitoring network. In 2014, an Explanation of Significant Differences for the Revision 1 ROD Remedial Alternative Selection for the LASG OU (SRNS 2014a) was issued which set a contained-in determination that groundwater concentrations with the LASG OU monitoring network of at or below 56 µg/L for PCE and 54 µg/L for TCE would not be considered RCRA listed waste and purge water can be discharged to the ground. If levels are above the limits, then containerization of the groundwater will be required for treatment or disposal. The MNA monitoring results are reported via biennial Effectiveness Monitoring Reports (EMRs) or groundwater data summary report letters. MNA will be performed until RGs are achieved (estimated in approximately 2090).
- LUCs are being enforced for all groundwater contaminated above MCLs within the OU and under adjacent portions of L-Lake. Restrictions on the use of groundwater within the LUC outline will be enforced as long as contaminant levels exceed MCLs.

The estimated operation and maintenance (O&M) costs associated with the selected remedy for LASG includes long-term groundwater monitoring and reporting and LUCs (WSRC 2007a). The estimated O&M cost from the ROD since the last remedy review for these activities is $227,560 for FY2012 through FY2015. The actual O&M cost for FY2012 through FY15 is $216,272.

## V. Progress Since Last Review

The previous protectiveness statement concluded that the remedial actions at LASG OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks are being controlled by LUCs that have been functioning properly.

During the last five-year remedy review in 2012, it was determined that performance monitoring of the remedial actions at the LRSB and LAOCB were not being performed during LASG OU sampling and monitoring. To monitor potential contaminant migration issues at the LRSB, strontium-90 was added to the analytes monitored at well LSB 4 on a 5-year cycle beginning in 2012. Performance monitoring for LAOCB remedy was also implemented in 2012 by sampling monitoring wells LCO 2DL and LCO 6DL for constituents detected in the LAOCB soils (carbon-14, cobalt-60, strontium-90, tritium, non-volatile beta, and gross-alpha with uranium isotopes analyzed if gross-alpha exceeds the trigger limit of 15 pCi/L). Table G-5 present the performance monitoring results from 2012 and Figure G-4 shows the associated locations of the stations sampled. Although the additional sampling was implemented under the LASG OU monitoring program, the purpose was to verify the effectiveness of the remedies for the LRSB and LAOCB, not to evaluate the effectiveness of the LASG OU MNA remedy.

Optimizations to the monitoring and reporting requirements were developed for the LASG OU were implemented in 2012 and captured in the addendum to the EMP (SRNS 2013). VOC analyses were added to well LSW029DL, sampling frequency was reduced at 19 monitoring wells from annually to biannually, and the reporting frequency for EMRs was reduced from a 2-year to a 4-year cycle with an interim 2-year data summary report in letter format. The first data summary report was submitted in 2014 (SRNS 2014b).

## VI. Five-Year Review Process

The following tasks were performed as part of the five-year review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed implementation of the remedial action;

- Reviewed all process and performance monitoring data provided by biennial EMRs and provided a technical assessment of whether MNA is functioning as intended by the ROD;
- Inspected the OU, interviewed maintenance personnel, and documented the results on the Inspection Checklist provided in Attachment G-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

***Data Review***

Two biennial EMRs have been submitted to date and were reviewed (SRNS 2010; SRNS 2012). These reports include all sample results for tritium, PCE, and TCE collected from monitoring wells and surface water stations during 2008 through 2011, time-series plots at each station since 1993, and plume maps. In 2014, a biennial data summary letter report was submitted and reviewed which presented the sampling results during 2012 and 2013 and included plume maps (SRNS 2014b).

***Summary of Inspections and Interviews***

Interviews were conducted with Richard Feagin, O&M staff member, and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The LASG OU was inspected by SRNS and USDOE personnel on July 13, 2015 and October 26, 2015, respectively. No issues were identified for the LASG OU during this inspection and interviews.

## VII. Technical Assessment

### Is the Remedy Functioning as Intended by the Decision Document?

The remedy is expected to function as intended as demonstrated below:

- The selected remedy component of LUCs is effective in preventing human exposure to groundwater above MCLs. The Land Use Control Implementation Plan for LASG OU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2009). All LUC objectives are being met.

- The selected remedy (MNA) is effective in treating groundwater to reduce the amount of discharge of groundwater exceeding MCLs to L-Lake as reported in the biennial EMRs and groundwater data summary letter reports. The sources of the groundwater contamination have been depleted. The processes of dispersion, dilution, and radioactive decay are lowering contaminant levels at LASG OU, such that groundwater will be restored to concentrations below MCLs in a reasonable timeframe.

Tritium levels have decreased in source zone monitoring wells dramatically over the last 10 to 15 years with values dropping from over 1,000 pCi/mL to currently under the MCL of 20 pCi/mL. These decreasing tritium levels are shown in the time-series plot for well LAW 2 (Figure G-5). The surface water data from station SC27 in Table G-3 further demonstrates that contaminated groundwater discharging to L-Lake quickly mixes with the surface water and tritium levels exiting L-Lake are well below the MCL. All LUC boundary wells remain non-detect or of low concentrations below the MCL. All three tritium plumes (Figure G-2) are shrinking and migrating as expected from modeling (WSRC 2004).

The PCE and TCE plumes have decreased in size over the last 10 years. Contaminant levels are not increasing (Figure G-6), and the plumes are progressing as expected from modeling (WSRC 2004). L-Lake surface water results have remained well below the MCL (5 µg/L) for PCE and TCE, with the majority of the results being non-detect. These results are due to the rapid dispersion and volatilization of VOCs within the lake. LUC boundary wells remain non-detect for VOCs.

More detailed discussions on the tritium and VOC plumes can be found in the previous two biennial EMRs from 2010 and 2012 respectively (SRNS 2010; SRNS 2012) and the 2014 biennial data summary letter report (SRNS 2014b).

Modeling predicted that groundwater would remain contaminated for approximately 90 years (until approximately 2090) (WSRC 2004). MNA remains the best option for the contaminated groundwater as contaminant levels are decreasing, the plumes are decreasing in size, and contaminant levels in L-Lake are not discharging above MCLs and are showing a decreasing trend.

Additionally, 2012 data results from the LRSB and LAOCB performance monitoring sampling showed there are no contaminant migration concerns associated with their associated surface units (Table G-5; Figure G-4).

**Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?**

The exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection are still valid. The MCLs for tritium, PCE, and TCE have remained the same since the remedies were implemented as shown in Appendix B. There have been no changes in standards or physical conditions of the LASG OU that would affect the protectiveness of the remedy.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No new information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

There are no issues related to current site conditions that prevent the remedy from being protective.

## IX. Recommendations and Follow-up Actions

There are no recommendations or follow-up actions for the LASG OU.

## X. Protectiveness Statement(s)

The remedy at the LASG OU is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., land use controls) to prevent exposure to or ingestion of contaminated groundwater. These land use controls include physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the LASG OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater Remedies is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2010. *Biennial Effectiveness Monitoring Report for Monitored Natural Attenuation at the L-Area Southern Groundwater Operable Unit (U) 2008 through 2009*, SRNS-RP-2010-00989, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *Biennial Effectiveness Monitoring Report for Monitored Natural Attenuation at the L-Area Southern Groundwater Operable Unit (U) 2010 through 2011*, SRNS-RP-2012-00169, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2013. *Addendum to the Monitored Natural Attenuation Effectiveness Monitoring Plan for the L-Area Southern Groundwater Operable Unit (NBN)(U)*, SRNS-RP-2012-00857, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS 2014a. *Explanation of Significant Differences for the Revision 1 Record of Decision Remedial Alternative Selection for the L-Area Southern Groundwater Operable Unit (NBN) (U)*, SRNS-RP-2012-00736, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014b. *Biennial Effectiveness Monitoring Report (Sampling Summary) for the Monitored Natural Attenuation at the L-Area Southern Groundwater Operable Unit, 2012 through 2013*, ACP-14-169, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report,* U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1999. *Corrective Measures Implementation/Remedial Design Report/Remedial Action Work Plan (CMI/RDR/RAWP) for L-Area Oil and Chemical Basin (904-83G) (U)*, WSRC-RP-97-844, Revision 1.4, Westinghouse Savannah River Company, LLC, Savannah River Site, Aiken SC

WSRC, 2002. *Unit-Specific Plug-In Record of Decision Amendment for the C-Area Reactor Seepage Basin (904-67G) and L-Area Reactor Seepage Basin (904-64G) (U)*, WSRC-RP-2002-4063, Revision 1, Westinghouse Savannah River Company, LLC, Savannah River Site, Aiken, SC

WSRC, 2004. *Groundwater Flow and Transport Model of the L-Area Southern Groundwater Operable Unit (U)*, WSRC-RP-2004-4082, Revision 0, Westinghouse Savannah River Company, Savannah River Site, Aiken SC

WSRC, 2005. *RCRA Facility Investigation/Remedial Investigation for the L-Area Southern Groundwater Operable Unit (U)*, WSRC-RP-2003-4171, Revision 1.1, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007a. *Record of Decision for the L-Area Southern Groundwater Operable Unit (NBN) (U)*, WSRC-RP-2006-4052, Revision 1.1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2007b. *Corrective Measures Implementation/ Remedial Action Implementation Plan for the L-Area Southern Groundwater Operable Unit (NBN) (U),* WSRC-RP-2007-4050, Revision 0, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2008. *Monitored Natural Attenuation Effectiveness Monitoring Plan for the L-Area Southern Groundwater Operable Unit (NBN) (U)*, WSRC-RP-2007-4048, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

WSRC, 2009. *Land Use Control Implementation Plan for L-Area Southern Groundwater Operable Unit (NBN) (U),* WSRC-RP-2007-4049, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

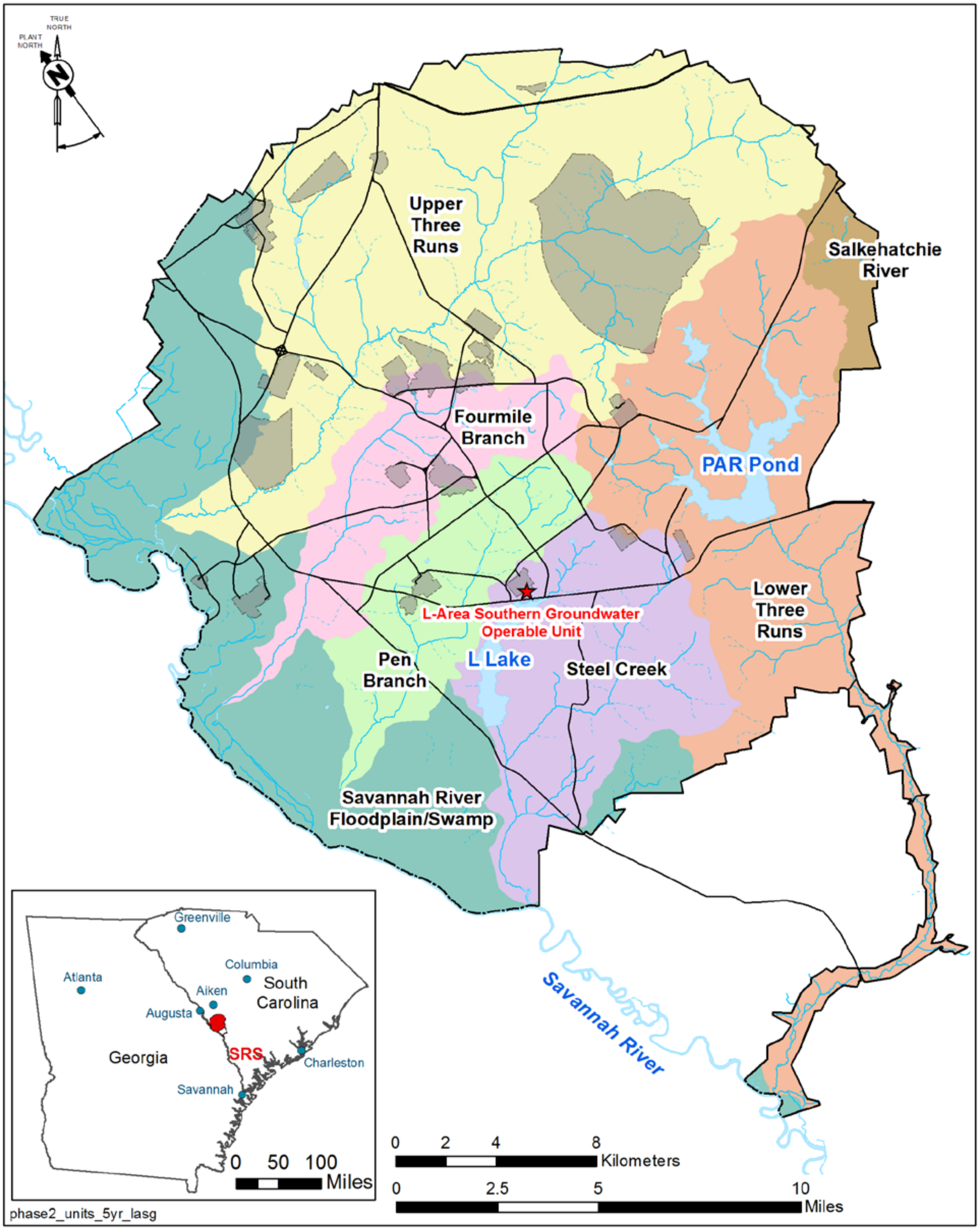


**Figure G-1. Location of the L-Area Southern Groundwater OU at SRS**

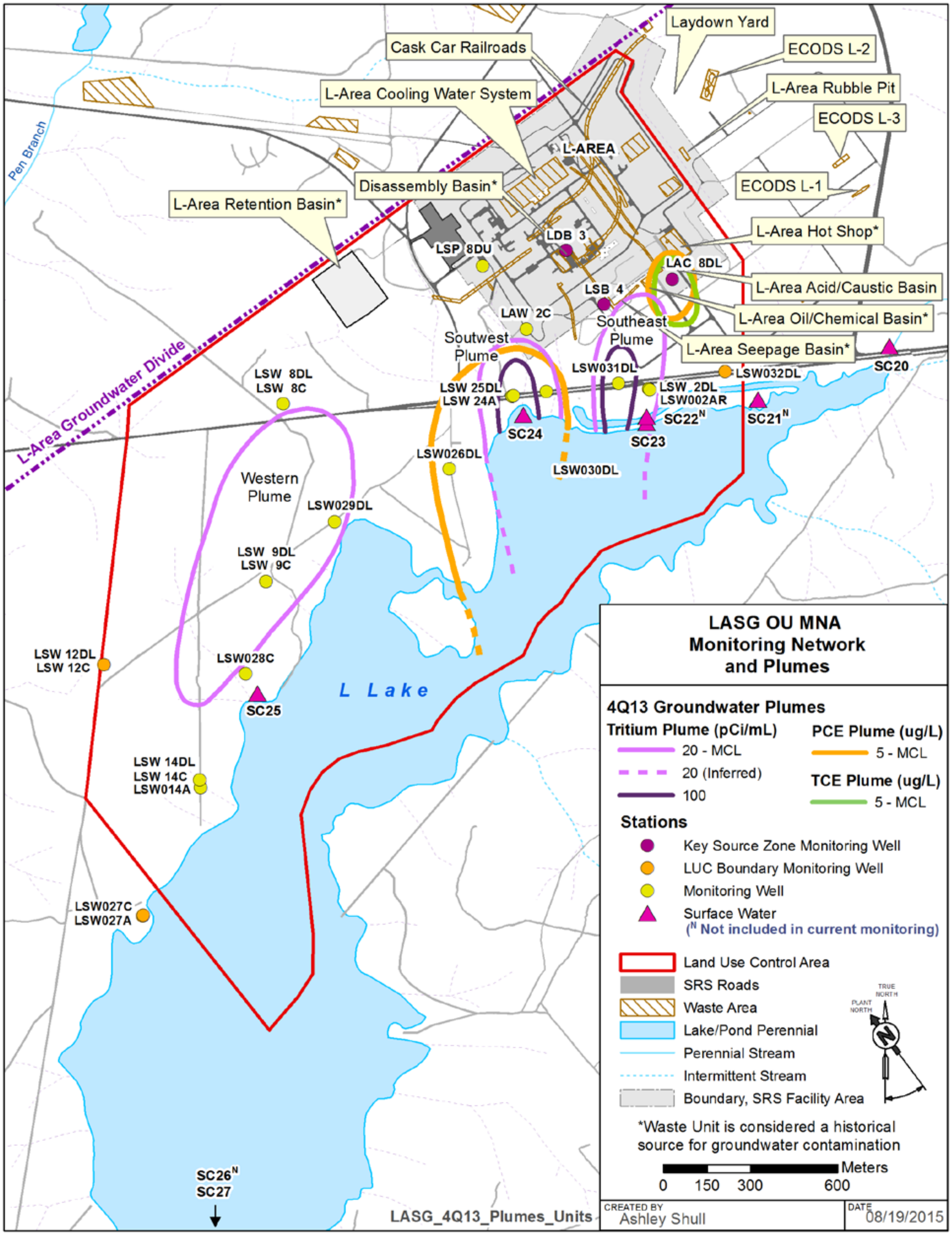


Figure G-2. Layout of the L-Area Southern Groundwater Operable Unit with Plumes

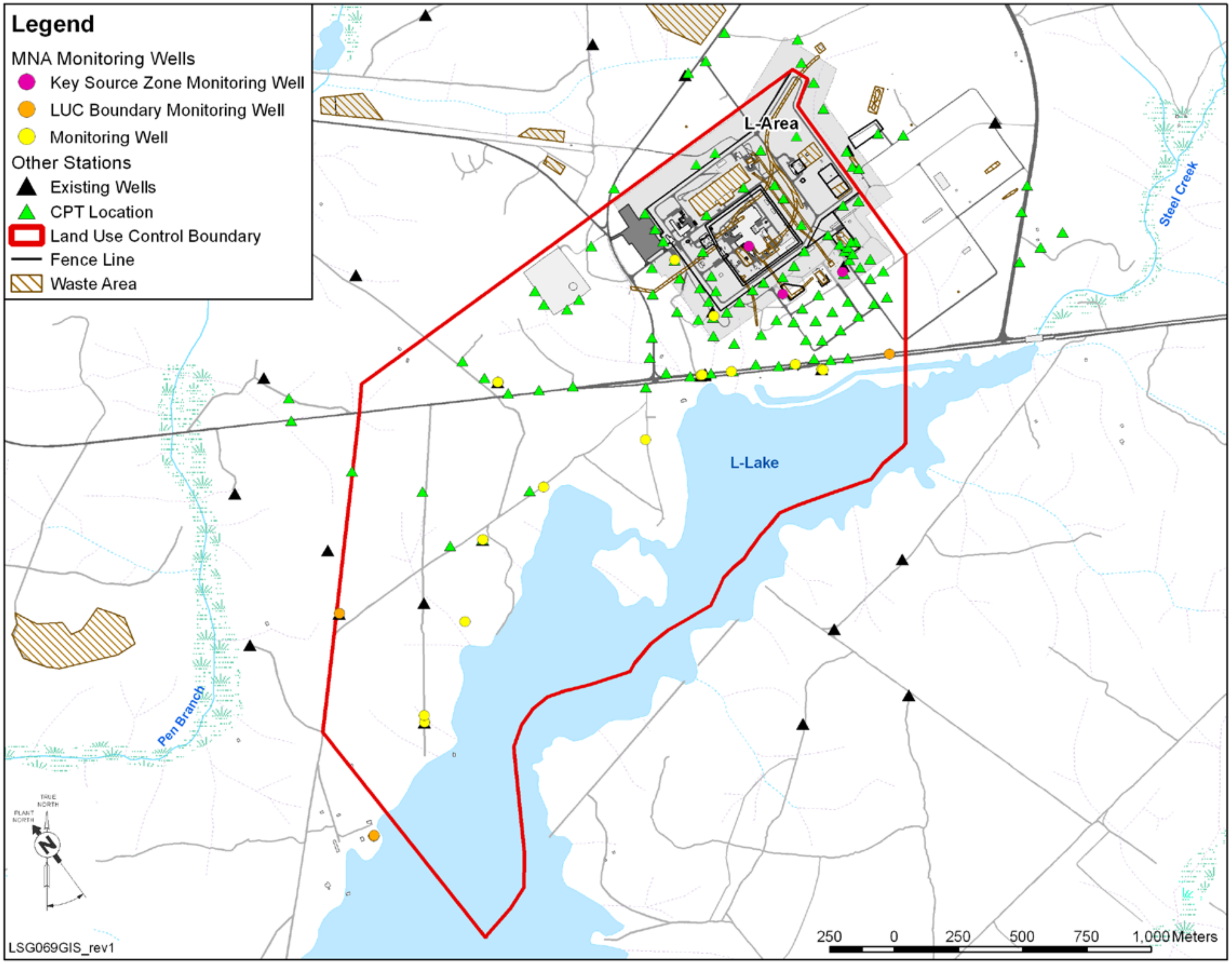


**Figure G-3. Well and CPT Coverage Map**

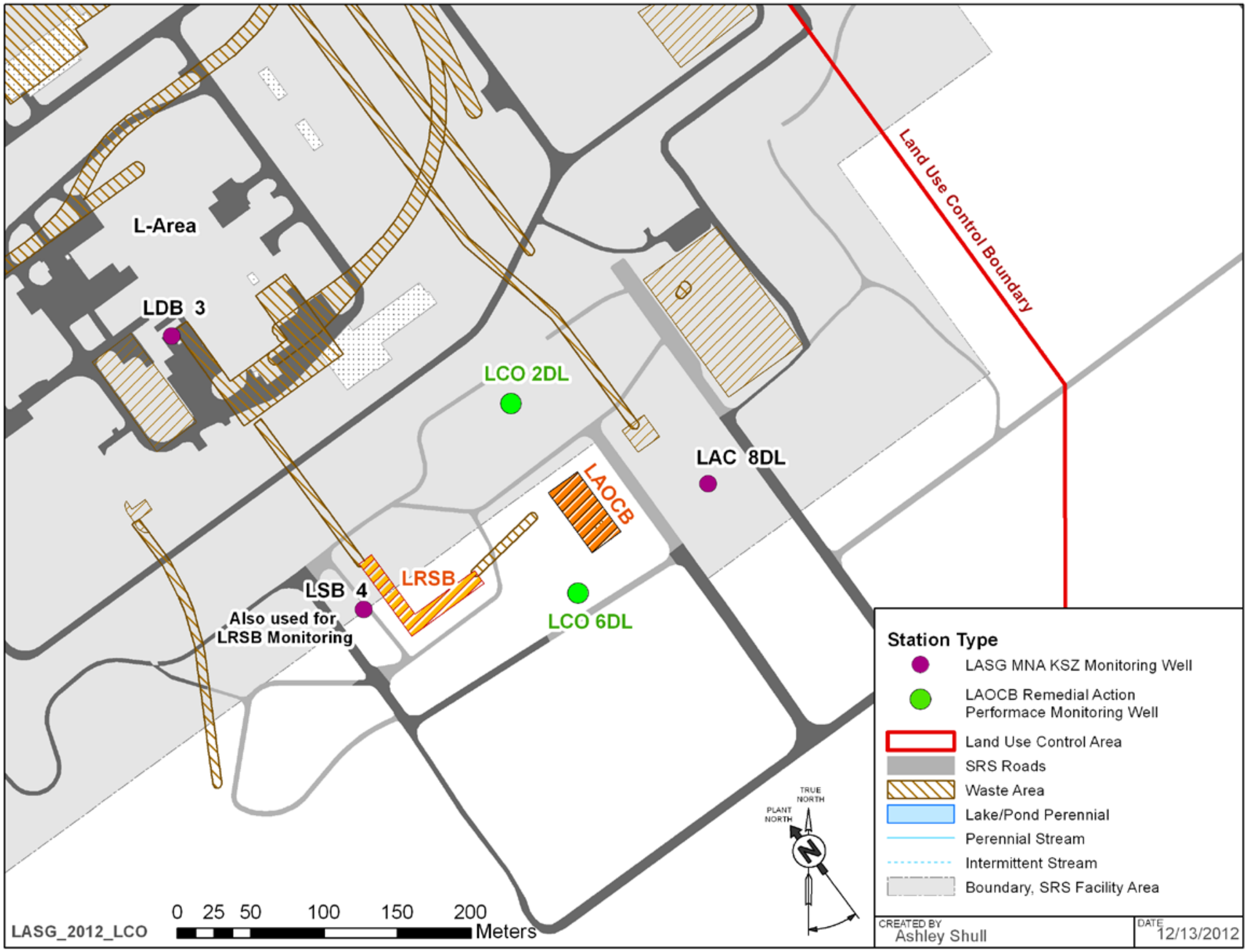


Figure G-4. LRSB and LAOCB Performance Monitoring Station Locations

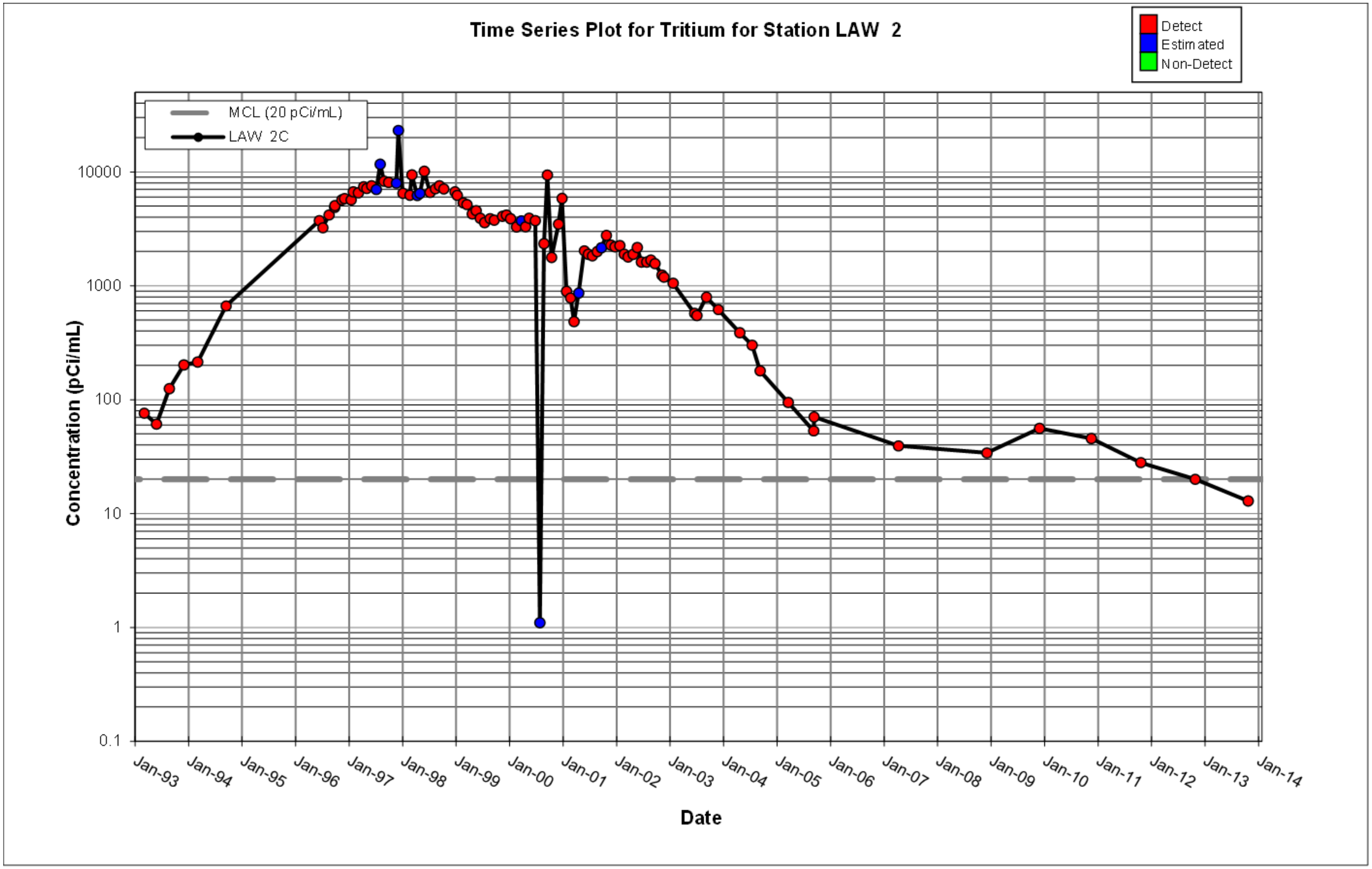


**Figure G-5. Time Series Plot for Tritium for Source Zone Well LAW 2**

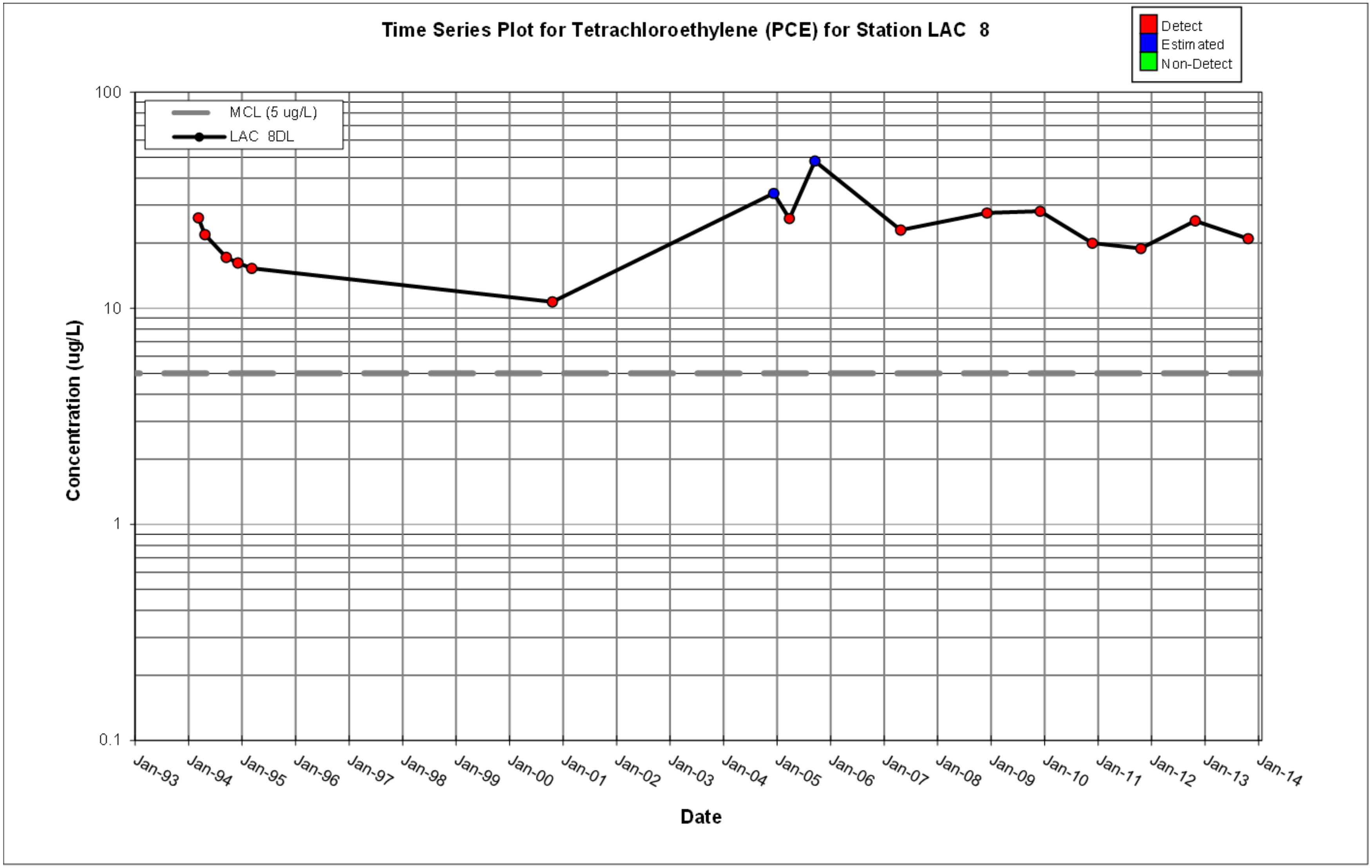


**Figure G-6. Time Series Plot for PCE for Source Zone Well LAC 8DL**

**Table G-1. Chronology of Events**

| Event | Date |
|---|---|
| Remedial Investigation (RI) Start / Complete | August 2, 2000 / July 26, 2004 |
| Record of Decision (ROD) Issuance | April 26, 2007 |
| Remedial Action Construction Start / Complete | February 25, 2008 / May 7, 2008 |
| Remedial Action Operations Start / Complete | December 8, 2008 / on-going |
| Previous Five-Year Review | February 4, 2009 / February 4, 2014 |

**Table G-2. MCL Listing for LASG and Maximum Groundwater Results Summary**

| RCOC | MCL | Pre-RI 1981 - 1999 | RI Jan '00 – Jul '04 | Post-RI Jul 26, 2004 – 2013 | Present |
|---|---|---|---|---|---|
| **Range of dates** | | **Prior to 2001** | **2001 - 2004** | **2005 - 2013** | **2014** |
| Tritium (ρCi/mL) | 20 | 26,200 | 5,850 | 1230 | 650 |
| PCE (µg/L) | 5 | 165 | 58 | 60 | 62 |
| TCE (µg/L) | 5 | 124 | 9 | 21 | 6.2 |

**Table G-3. Analytical Results for Tritium (ρCi/mL) in L-Lake**

| Station ID | Oct 2005 | Jun 2006 | Dec 2006 | May 2007 | Dec 2007 | Dec 2008 | Dec 2009 | Dec 2010 | Oct 2011 | Oct 2012 | Nov 2013 | Nov 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC20 | 16.5 | 14.2 | **58.1** | 14.2 | 18.9 | **20.5** | **58.2** | **49.2** | **54.5** | 11.1 | 11.2 | 7.36 |
| SC21 | 14.3 | 13.9 | 14.2 | 13.8 | NS | NS | NS | NS | NS | NS | NS | NS |
| SC22 | J 0.984 | 2.14 | J 2.1 | 4.27 | NS | NS | NS | NS | NS | NS | NS | NS |
| SC23 | **30** | 19.5 | **234** | **33.5** | 11.6 | **54.9** | ND | J 0.558 | 1.34 | ND | 3.38 | ND |
| SC24 | **22.1** | **53.2** | **257** | **34.3** | **30.7** | **47.7** | **78.3** | **145** | **28.9** | **105** | 7.24 | 4.63 |
| SC25 | 13.3 | 9.8 | 12 | 11.9 | 8.98 | 5.17 | 6.41 | 7.2 | 6.49 | 5.11 | 3.93 | 4.06 |
| SC26 | 11.3 | 12.9 | 12.8 | 12.7 | NS | NS | NS | NS | NS | NS | NS | NS |
| SC27 | 11.9 | 11.9 | 9.24 | 12 | 10 | 8.17 | 6.22 | 6.94 | 6.88 | 5.96 | 4.79 | 4.77 |

J: Qualifier on a value indicates that the analyte was positively identified in the sample at a concentration below the quantitation limit; the reported value is estimated. NS: Not Sampled. ND: Not Detected. Note: Results in bold face type exceed the 20 pCi/mL MCL for tritium.

**Table G-4. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs ($) | 87,937 | 79,088 | 25,280 | 23,967 | 216,272 |
| Total ROD Estimated Direct O&M Costs ($) | 75,640[1] | 50,640 | 50,640 | 50,640 | 227,560 |

[1]FY2012 estimated costs include costs associated with the fourth five-year remedy review.

**Table G-5. LAOCB and LRSB Performance Monitoring Results (2012)**

| **LAOCB Results - 10/31/2012** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | CARBON-14 | COBALT-60 | GROSS ALPHA | NONVOLATILE BETA | POTASSIUM-40 | STRONTIUM-90 | TRITIUM |
| Units | pCi/L | pCi/L | pCi/L | pCi/L | pCi/L | pCi/L | pCi/mL |
| MCL/PRG | 1.43 | 3.37 | 15 | 50 | 2.14 | 8 | 20 |
| LCO 2DL | ND | ND | ND | ND | ND | ND | J 0.718 |
| LCO 6DL | **J 9.95*** | ND | ND | J 5.19 | ND | ND | 1.66 |
| | | | | | | | |
| **LRSB Results - 10/31/2012** | | | | | | | |
| LSB 4 | NR | NR | NR | NR | NR | ND | 19.3 |

*The lab duplicate sample was non-detect. J: Qualifier on a value indicates that the analyte was positively identified in the sample at a concentration below the quantitation limit; the reported value is estimated. NR: Not Required. ND: Not Detected. Note: Results in bold face type exceed the MCL or PRG.

## Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit

| I. SITE INFORMATION | | | |
|---|---|---|---|
| **Site Name:** | **L-Area Southern Groundwater Operable Unit** | **Date of Inspection:** | **07/13/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS #31** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **91°F and clear** |

**Remedy Includes:** *(Click all that apply)*

- ☐ Landfill Cover/Containment
- ☒ Access Controls
- ☒ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☒ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☐ Other ______________________________

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

### II. INTERVIEWS *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) — Post Closure Manager (Title) — 07/15/2015 (Date)

**Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

**Problems/Suggestions:** ☐ Report Attached ______________________________

2. **O&M Staff:** Richard Feagin (Name) — ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) — 07/15/2015 (Date)

**Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-4416

**Problems/Suggestions:** ☐ Report Attached ______________________________

## Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit *(continued)*

### II. INTERVIEWS *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ____________________

**Contact:** ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached No issues identified.

**Agency:** ____________________

**Contact:** ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached

**Agency:** ____________________

**Contact:** ________ (Name) ________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached

4. **Other Interviews** *(Optional):* ☐ Report Attached

### III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Monitoring wells are inspected per ER-SOP-011, "ACP Monitoring Well Inspection (U)"

**Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit *(continued)***

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Continued)*

**1. Health and Safety Plans (HASPs):**

| | | | |
|---|---|---|---|
| ☐ Site-Specific Health and Safety Plans | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Contingency Plan/Emergency Response Plan | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER

**2. O&M and OSHA Training Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

**3. Permits and Service Agreements:**

| | | | |
|---|---|---|---|
| ☐ Air Discharge Permit | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Effluent Discharge | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Waste Disposal; POTW | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Other Permits | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**4. Gas Generation Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**5. Settlement Monument Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**6. Groundwater Monitoring Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**7. Leachate Extraction Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**8. Discharge Compliance Records:**

| | | | |
|---|---|---|---|
| ☐ Air | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Water (Effluent) | ☐ Readily Available | ☐ Up to Date | ☒ N/A |

Remarks:

**9. Daily Access/Security Logs:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

**Total annual cost by year for review period, if available**

From:________ To:________ ________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:________ To:________ ________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:________ To:________ ________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:________ To:________ ________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:________ To:________ ________ ☐ Breakdown attached
(Date) (Date) (Total Cost)

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☒ Applicable ☐ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks:

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☒ N/A

Remarks: Signs at this site are in good condition.

**Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS** *(Continued)*

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walk-throughs
Frequency: Annual
Responsible Party/Agent: USDOE Savannah River Field Office

| Contact: | Phil Prater | RCRA/Remedial Program Manager | 10/26/15 | 803-952-9333 |
|---|---|---|---|---|
| | (Name) | (Title) | (Date) | (Phone No.) |

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

**2. Adequacy:** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: Survey orange balls are present and in good condition.

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit *(continued)***

| VI. GENERAL SITE CONDITIONS |
|---|
| **A. Roads** ☒ Applicable ☐ N/A |
| **1. Roads damaged:** ☐ Location shown on site map ☒ Roads adequate ☐ N/A<br>Remarks:___ |
| **B. Other Site Conditions** |
| Remarks:___ |
| **VII. LANDFILL COVER/CONTAINMENT** ☐ Applicable ☒ N/A |
| **VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A |
| **IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A |
| **A. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **C. Treatment System** ☐ Applicable ☒ N/A |
| **D. Monitoring Data** ☒ Applicable ☐ N/A |
| **1. Monitoring Data:**<br>☒ Is routinely submitted on time ☒ Is of acceptable quality |
| **2. Monitoring Data:**<br>☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining |
| **E. Monitored Natural Attenuation** ☒ Applicable ☐ N/A |
| **1. Monitoring Wells** *(natural attenuation remedy)***:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition<br>☒ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks: All MNA groundwater monitoring wells were inspected. All well identification signs were in good condition. |
| **X. OTHER REMEDIES** |
| If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. |
| **A. Soil Vapor Extraction System** ☐ Applicable ☒ N/A |

## Attachment G-1. Five-Year Review Site Inspection Checklist – L-Area Southern Groundwater Operable Unit *(continued)*

| XI. OVERALL OBSERVATIONS |
|---|
| **A. Implementation of the Remedy** |
| Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).<br><br>Groundwater monitoring indicates the remedial action was successful. MNA remains the best option for the contaminated groundwater as contaminant levels are decreasing, the plumes are decreasing in size, and contaminant levels in L-Lake are not discharging above MCLs and are showing a decreasing trend. |
| **B. Adequacy of O&M** |
| Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.<br><br>The protectiveness of the completed remedial action is being monitored by continued groundwater sampling. The O&M procedures are effectively maintaining the monitoring wells. The wells are properly secured/locked, functioning and are in good condition. Institutional controls effectively prevent unauthorized access to the groundwater and include physical access controls to SRS (fences, guards, security patrols, etc.); administrative controls (SRS is a secured government facility with land use restrictions); and use controls (SRS Site Use/Site Clearance Program). |
| **C. Early Indicators of Potential Remedy Failure** |
| Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.<br><br>N/A |
| **D. Opportunities for Optimization** |
| Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.<br><br>N/A |

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## R-AREA OPERABLE UNIT

### I. Introduction

This report is the second five-year review for the R-Area Operable Unit (RAOU). The review was conducted from August 2015 through November 2015. Contaminants have been left in place at RAOU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at RAOU is protective of human health and the environment. This report documents the results of the review.

### II. OU Chronology

Table H-1 lists the chronology of site events for the RAOU.

### III. Background

The RAOU is listed as a Resource Conservation and Recovery Act (RCRA)/ Comprehensive Environmental Response, Compensation, and Liability Act unit in Appendix C of the Federal Facility Agreement (FFA) (FFA 1993) for Savannah River Site (SRS). The media of concern is surface soil, rail bed materials, metal components, concrete, sediment, and groundwater.

An area-based remedial strategy has been implemented in R Area, excluding prior remedial decisions for the following Operable Units (OUs) as presented in their respective Record of Decisions (RODs) documents:

- R-Area Reactor Seepage Basins,(904-57G, -58G, -59G, -60G, -103G, and -104G) and 108-4R Overflow Basin (108-4R),
- R-Area Acid/Caustic Basin ( 904-77G),
- R-Area Bingham Pump Outage Pits (643-8G, 643-9G, and 643-10G), R-Area Unknown Pit #1 (RUNK-1), Pit #2 (RUNK-2), and Pit #3 (RUNK-3) (No Building Number [NBN]), and

- R-Area Burning/Rubble Pits (131-R and -1R) and R-Area Rubble Pile (631-25G).

RAOU remedial actions are addressed by the Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009b) and the ROD for the RAOU (SRNS 2010a). Removal actions were completed for the following units within R Area and the actions described in Decommissioning Project Final Reports and Engineering Evaluation/Cost Analysis (EE/CA) Reports:

- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (SRNS 2009c),
- Grouting of the R-Reactor Disassembly Basin at the Savannah River Site (USDOE 2002),
- R-Reactor Building (105-R) Complex (SRNS 2009d),
- P-Area Ash Basin (Including Outfall P-007) (188-P) and the R-Area Ash Basin (188-R) (SRNS 2010d),
- R-Area Process Sewer Line (RPSL) Combined Subunit (SRNS 2010e), and
- Primary Substation (151-1R) (High Volt 115/13.8KV) (SRNS 2010f).

**Physical Characteristics**

The RAOU is located in east-central SRS approximately 5.0 km (3.1 mi) east of the geographical center of SRS and about 7.0 km (4.3 mi) west of the nearest site boundary (Figure H-1). RAOU is approximately 70.8 hectare (175 acre) and is located primarily in the Lower Three Runs watershed. The northwestern portion of the RAOU lies within the Upper Three Runs Watershed. Figures H-3 and H-4 show before (1999) and after (2015) remediation photos of R Area, respectively. The RAOU has a flat to gently rolling topography, and is approximately 88.4 m (290 ft) above mean sea level (msl).

The RAOU is comprised of the following subunits and potential source areas (PSAs) (Figure H-2):

- R-Reactor Building (105-R) Complex:
  - R-Reactor Building (105-R) including the Engine Houses (108-1R and 108-2R),

        - R-Reactor Vessel,
        - R-Reactor Disassembly Basin, and
        - R-Reactor Emergency Basin,
    - Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin (NBN),
    - Combined Spills North of Building 105-R (NBN), and
    - Potential Release from the R-Area Disassembly Basin
- RPSL Combined Subunit:
    - R-Area Process Sewer Lines (PSLs) as Abandoned (NBN),
    - Process Water Storage Tank (106-R) PSA,
    - Cooling Water Effluent Sump (107-R), and
    - Purge Water Storage Basin (109-R)
- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN),
- R-Area Ash Basin (188-R),
- R-Area Groundwater (RAGW) (NBN),
- R-Area Isolated Contamination Area (ICA) PSA(NBN),
- Process Storage Building (122-R),
- Potential Release of NaOH/$H_2SO_4$ from 183-2R,
- Power House (184-R) PSA,
- Cooling Tower (185-R) PSA,
- Former Coal Pile (NBN) PSA,
- Administrative and Maintenance Building (704-R) PSA,

- Maintenance Material Storage Building (711-R) PSA, and
- Eastern Volatile Organic Compound (VOC)/Tritium Groundwater plume PSA.

Within the RAOU area are the following Deactivation and Decommissioning No Further Action (NFA) Facilities and Site Evaluation NFA Areas:

- Primary Substation (151-lR),
- Primary Substation (151-2R),
- Cooling Water Clarification Plant (183-1R),
- Filter and Softener Plant (183-2R),
- Cooling Water Reservoir (186-R),
- Cooling Water Pump House (190-R), and
- Potential Release from R-Area Concrete Lakes (183-1R/186-R)

**Land and Resource Use**

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates much of RAOU as being within the site industrial support area. The land use control (LUC) boundaries for RAOU that encompass the groundwater plume are predominantly outside of the industrial area for R Area. However, shallow groundwater and surface water at SRS are not used for drinking water, hygiene, recreation, and process water. The future land use for RAOU is reasonably anticipated to remain industrial with the U.S Department of Energy (USDOE) maintaining control of the land.

**History of Contamination**

In December 1953, R-Reactor began operations, and the facility was placed in shutdown status in 1964 due to decreased demand for nuclear materials. The primary sources of radioactive contamination in R Area are activation products, fission products, and tritium, the majority of which were the consequence of R-Reactor operations. Spills, leaks, accidental releases, or simply the operation itself resulted in releases of hazardous and/or radioactive substances. Tritium and VOCs released from reactor operations have created four contaminated groundwater plumes in R Area (Figure H-2). A Northern Tritium Plume originates at the R-Reactor Seepage Basins, travels to the northwest, and discharges to surface water at Mill Creek. An Eastern Tritium Plume originates outside of the Purification Area of R-Reactor (105-R), travels to the northeast, and discharges to surface water at Joyce Branch. A Western Tritium Plume originates at the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) at the western end of R-Reactor (105-R), migrates to the south, but decays to below detection concentrations prior to discharging to a surface water body. An Eastern VOC Plume originates outside the Assembly Area of R-Reactor (105-R), travels to the northeast, and discharges to surface water at Joyce Branch.

**Initial Response**

R-Reactor Building (105-R) and all other facilities within R Area have been decommissioned and/or are remnants that require no further action. The Early Action ROD for the C-, K-, L-, and R-Reactor Complexes (SRNS 2009b) documents the selected remedy for the R-Reactor Building (105-R) Complex as in situ decommissioning (ISD) with LUCs. Regulatory decisions were made previous to the RAOU ROD at selected RAOU subunits. Non-Time Critical removal (NTCR) removal actions are documented in five EE/CAs and include the following subunits and actions:

- R-Reactor Building (105-R) Complex (including the R-Reactor Building [105-R], the Engine Houses [108-lR and 108-2R], the R-Reactor Vessel, the R-Reactor Disassembly Basin, the R-Reactor Emergency Basin, the Area on the North Side of Building 105-R, Laydown Area North of 105-R, Release from the Decontamination of R-Area Reactor Disassembly Basin [NBN], Combined Spills North of Building 105-R (NBN), and the Potential Release from the R-Area Disassembly Basin [105-R]) – in situ decommissioning (SRNS 2009d),
- R-Reactor Disassembly Basin – evaporation and grouting (USDOE 2002),

- RPSL Combined Subunit (including the R-Area PSLs as Abandoned [NBN], Process Water Storage Tank [106-R], Purge Water Storage Basin [109-R], Cooling Water Effluent Sump [107-R] Subunit, Septic Tank [607-lR], outfalls, manholes, miscellaneous weirs and boxes; sumps, etc.) – grouting access points and open structures (SRNS 2010e),
- R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit – excavation and disposal (SRNS 2009c), and
- R-Area Ash Basin (188-R) Subunit – soil cover (SRNS 2010d).

**Basis for Taking Action**

The nature and extent of contamination in soil, sediment, surface water, and groundwater at the RAOU were characterized. Results from the past characterization activities (SRNS 2009a) and recent monitoring have demonstrated that residual contaminants exceed the R-Reactor Building (105-R) Complex ISD remedial goals (RGs) at specific subunits. In addition, there are three tritium plumes and one VOC plume, which comprise the RAGW Subunit, that exceed the maximum contaminant levels (MCLs) (Table H-2). The shallow groundwater aquifers impacted by tritium and VOCs in R Area have never been used as drinking water; however, until tritium and VOCs are reduced below MCLs, the potential for human exposure requires action. ISD of the R-Reactor Building (105-R) left radionuclides, lead, and polychlorinated biphenyls (PCBs) in place at levels that present a potential for future contaminant migration to groundwater (SRNS 2010a). Therefore, monitoring of the R-Reactor Building (105-R) Complex ISD is required to ensure groundwater is not impacted by the residual contaminants. Table H-3 summarizes the refined constituents of concern (RCOCs) and remedial goals (RGs) determined for the RAOU subunits. RAOU subunits with contaminant levels that exceed 1.0E-06 risk for an industrial worker scenario required the following removal actions, LUCs, and monitoring to be protective of human health and the environment:

- The removal action for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit (soil removal to 10 ρCi/g cesium-137) has been completed

(SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.

- The removal action for the R-Reactor Disassembly Basin has been completed and radioactive contaminants have been grouted in place (SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.
- The removal action for the R-Reactor Building (105-R) Complex has been completed and radioactive contaminants have been grouted in place (SRNS 2012). This subunit will be managed with the LUCs selected for the entire RAOU to prevent unrestricted use.
- The removal action for the R-Area PSLs has been completed and radioactive contaminants have been left in place (SRNS 2012). The subunit requires LUCs selected for the entire RAOU to prevent unrestricted use.
- A contaminant migration analysis was performed to identify refined contaminant migration constituents of concern (COCs) (SRNS 2009a).
- A principal threat source material (PTSM) evaluation for the RAOU subunits determined refined COCs for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned, R-Area PSLs, and R-Reactor Building (105-R) Complex subunits. The radioactive inventory located in the R-Reactor Building (105-R) has been estimated to be $6.39 \times 10^4$ Ci (SRNS 2009d), and the cumulative risk for the R-Reactor Building (105-R) Complex was estimated at $5.61 \times 10^1$ (SRNS 2009a).

## IV. Remedial Actions

### Remedy Selection

As stated in the ROD (SRNS 2010a), the selected remedy for the RAOU is MNA with LUCs as follows:

- LUCs include: (1) institutional controls (i.e., administrative measures) and use restrictions for on-site workers via the Site Use/Site Clearance Program. Other administrative controls to ensure worker safety include work controls, worker training, and worker briefing of health and safety requirements; (2) engineering controls consisting of signage located at the RAOU LUC boundaries to discourage unauthorized entry and uses; and (3) SRS access controls to prevent exposure to trespasses including a 24-hour surveillance system, control entry systems, and warning signs in place at the SRS boundary, and

- Monitored Natural Attenuation (MNA).

As stated in the ROD (SRNS 2010a), the Remedial Action Objectives (RAOs) for the RAOU are as follows:

- Eliminate or control all routes of exposure to residual radioactive or chemical contamination posing risks exceeding $1x10^{-6}$ to the industrial worker or the resident in media or structures associated with the R-Reactor Building (105-R) Complex, the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned, the RPSL Combined Subunit, the R Area ICA PSA, the R-Area Ash Basin (188-P), and the RAGW,

- Prevent the migration of contaminants from residual water in the Process Water Storage Tank (106-R) PSA to groundwater at concentrations exceeding regulatory standards (MCLs),

- Prevent human exposure to tritium and VOCs in groundwater that exceed regulatory standards (MCLs) and restore contaminated groundwater to below regulatory limits (MCLs) for the RAGW Subunit, and

- Prevent exposure of potential contamination in media or structures to a residential receptor associated with the following subunits:
    - Process Storage Building (122-R) Subunit
    - Potential Release of $NaOH/H_2SO_4$ from 183-2R Subunit
    - Power House (184-R) PSA
    - Cooling Tower (185-R) PSA
    - Former Coal Pile (NBN) PSA

- Administrative and Maintenance Building (704-R) PSA
- Maintenance Material Storage Building (71 l-R) PSA
- Eastern VOC/Tritium Groundwater Plume PSA

**Remedy Implementation**

The selected remedial action was based on successful completion of the NTCR actions as listed below:

- Removed 53.6 $m^3$ (70 $yd^3$) of contaminated media at the R-Reactor Cask Car Railroad Tracks by excavating and transporting to the E-Area Slit Trenches for disposal. The excavated area was backfilled with structural fill material and approximately 10-cm (4-in) of crusher run was placed, graded, and compacted on the backfilled area.
- Placed a 6.1-hectare (15-acre), 0.6-m (2-ft) thick soil cover over the R-Area Ash Basin (188-R). The multi-layer cover system consisted of a 45-cm (18-in) thick compacted common fill, 10-cm (4-in) thick topsoil, and sod.
- Isolated/plugged the R-Area PSLs; grouted associated underground structures, manholes, weirs and boxes; select removal of process equipment external to the R-Area PSLs; sealed/plugged of outfalls; transported 60,000 gallons of radiologically contaminated water from the 106-R Process Water Storage Tank to R-Area Disassembly Basin for evaporation.
- ISD of the R-Reactor Building (105-R) Complex included:
  - Leaving the R-Reactor Building (105-R) (Process, Purification, and Assembly Areas) and the Actuator Tower in place,
  - Installing an evaporation system to treat the R-Reactor Disassembly Basin water; Grouting the below grade portions of the R-Reactor Building (105-R) including Disassembly Basin and the Purification Area (94,055 $m^3$ [122,948 $yd^3$] total) to stabilize contaminants,

- Grouting the Reactor Vessel in place (109.4 $m^3$ [143 $yd^3$]) and placing a 1.2-m (4-ft) thick constructed concrete cover over the Reactor Vessel; cover is sloped to allow water runoff in the event of future rainwater ingress,
- Demolishing the above-grade structure of the R-Reactor Disassembly Area to grade-level and transported 10,254 $m^3$ (13,404 $yd^3$) of debris to the E-Area Low-Level Waste Facility,
- Placed a 0.57 hectare (1.4 acre), 17.5-cm (7-in) thick sloped 4000 psi reinforced concrete cover over the grouted R-Reactor Disassembly Basin, including the contaminated soil and slabs in the area north of the R-Reactor Building (105-R),
- Removing the stack above the plus 16.8-m (55-ft) elevations,
- Constructing a new partial roof over the shield door slots to prevent rainwater ingress,
- Leaving the Process Room, an above-grade structure, in its current state,
- Monitoring the groundwater adjacent to the R-Reactor Building (105-R) in order to verify the effectiveness of the ISD remedy, and
- Sealing all R-Reactor Building (105-R) exterior openings.

The selected final remedy components met the RAOs at RAOU by implementing the following activities:

- MNA for the RAGW Subunit (SRNS 2010c),
- Performance evaluation groundwater monitoring for ISD of the R-Reactor Building (105-R) Complex, and
- LUCs for 183 hectares (450 acres) comprising the RAOU.

**System Operations/Operation and Maintenance**

Currently, there are no systems in operation at the RAOU. Operations are complete for the evaporators, which removed 4.5 to 5 million gallons of R-Reactor Disassembly Basin water. The remaining 380,000 gallons of shield water was absorbed/evaporated (through heat of hydration) by the grout.

The following maintenance activities are ongoing:

- Groundwater monitoring to ensure the ISD remedy is performing as expected and that no contaminant migration COCs have impacted groundwater. ISD monitoring is conducted every five years due to the long time-frame estimates for potential impacts to groundwater based on groundwater modeling. The first round of ISD groundwater monitoring was conducted in 2012; the next round of sampling is scheduled for 2017. Annual groundwater and surface water monitoring will be part of the MNA remedy for tritium and VOC plumes. The estimated time frames for MNA to restore contaminated groundwater to below MCLs based on data collected in 2007 to 2008 (SRNS 2010c) are:
    - Northern Tritium Plume - 124 years,
    - Eastern Tritium Plume - 77 years,
    - Western Tritium Plume 37 years, and
    - Eastern VOC Plume - 26 years.

Annual site inspections and maintenance activities include:

- The roof structure of the R-Reactor Building (105-R) Complex to ensure that it is functioning properly. Herbicides will be applied as necessary to prevent the growth of woody vegetation on the roof structure,
- The doors into the R-Reactor Building (105-R) Complex to ensure that they remain sealed,
- The R-Reactor Disassembly Basin cover to ensure that excessive deterioration has not occurred and that no woody vegetation is growing on the cover,
- The R-Area Ash Basin (188-R) cover to verify that significant erosion has not occurred (60.9 cm [2 ft] thickness maintained), to ensure that no woody vegetation is

growing on the cover, and to ensure that no burrowing or mounding animals are present,

- The RAOU to ensure no unauthorized excavations, digging, or construction activities within the LUC boundaries have occurred, and
- Inspection and maintenance of access control warning signs

The operation and maintenance (O&M) costs associated with the selected remedy for RAOU include maintenance costs, as described above, groundwater monitoring, and institutional controls (LUCs). These activities have a ROD estimated total present worth of $5,466,429 discounted at 2.7% per year for 200 years of maintenance activities (SRNS 2010a). The O&M cost estimated in the ROD that are applicable for FY2012 to FY2015 is $204,200. The actual O&M cost for this same period is $978,432. Table H-4 shows the annual comparison of O&M actual and ROD estimated costs. The actual costs are higher than expected because groundwater monitoring reports are being submitted annually. The ROD estimate only included reporting in an Effective Monitoring Report every five years to coincide with the remedy review. Additionally, based on inspections conducted from FY2012 through FY2015, various maintenance activities completed at the RAOU included cutting vegetation around waste unit warning signs, vegetation removal from stone armament, and vegetation removal from roofs.

## V. Progress Since Last Review

The previous protectiveness statement concluded that the remedy is protective of human health and the environment. Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated groundwater and soil media. All threats to contaminated soil at the RAOU have been addressed through implementation of soil covers, ISD, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the RAOU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

Monitoring activities since the last review indicate tritium and TCE concentrations are continuing to decrease in the groundwater and are not impacting surface water.

## VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Confirmed the implementation of remedial actions;
- Reviewed groundwater monitoring data to determine if MCLs were exceeded;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist, provided in Attachment H-1, with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance.

***Data Review***

Recent data (2012 to 2015) have been reviewed for the RAOU Groundwater subunit and ISD monitoring of the R-Reactor Building (105-R) Complex. The Eastern VOC, Eastern Tritium, Western Tritium, and Northern Tritium plumes all indicate decreasing concentrations over this time period.

ISD monitoring is conducted every five years due to the long time-frame estimates for potential impacts to groundwater based on groundwater modeling. The first round of ISD groundwater sampling was conducted in 2012, and the next round of ISD sampling is scheduled for 2017. Based on the 2012 data, none of the R-Reactor Building (105-R) Complex ISD constituents (chlorine-36, potassium-40, lead, nickel-59, niobium-94, molybdenum-93, iodine-129, PCBs, carbon-14, and silver-108[m]) were found to impact groundwater. All ISD monitoring results were below method detection limits, with the exception of tritium and one lead result.

***Summary of Inspections and Interviews***

Interviews were conducted with Richard Feagin, O&M staff member, on July 15, 2015 at the RAOU and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The RAOU was inspected by Savannah River Nuclear Solutions, LLC and USDOE personnel on July 23, 2015 and October 26, 2015. No issues were identified for the RAOU during these inspection and interviews.

## VII. Technical Assessment

### Is the Remedy Functioning as Intended by the Decision Document?

The remedies selected for the RAOU are functioning as intended, as demonstrated below:

The closure of the RAOU by ISD and maintaining a protective cover system over the R-Reactor Building (105-R) is meeting the remedial objectives of preventing physical exposure of contaminants as indicated by the following:

- Site inspection and maintenance data do not indicate problems or potential remedy failure, which could place protectiveness at risk (Attachment H-1).
- Per the Effectiveness Monitoring Plan (EMP) (SRNS 2010c), groundwater monitoring takes place every five years at ten wells located around the R-Reactor Building (105-R) (Figure H-5).
- Based on the results of the first ISD sampling event from March 2012, tritium (9 of 10 samples) and lead (6 of 10 samples) were detected, while no PCBs or other radionuclide results were above detection limits (Table H-2). The concentration of lead (25.4 μg/L) is above the MCL (15 μg/L) (SRNS 2010c). However, the lead result is consistent with previous results (maximum 24.1 μg/L) from well RDB 1D, rather than a new release from the R-Reactor Building (105-R) Complex. Nine of the ten tritium samples had concentrations exceeding the MCL (20 ρCi/ml) with the maximum concentration being 1650 ρCi/ml. These results are consistent with prior results (maximum 1710 ρCi/mL) from well RPS004C, and do not represent a recent

tritium release from the R-Reactor Building (105-R) Complex. The next round of ISD sampling is scheduled for 2017.

- The annual site inspection confirmed that the roof structure and R-Area Disassembly Basin cover are functioning properly, the doors are sealed, and the R-Area Ash Basin cover is in good condition (Attachment H-1).

- LUCs are preventing human health exposure and include the following: institutional controls (i.e., administrative measures) and use restrictions for on-site workers via the Site Use/Site Clearance Program; other administrative controls to ensure worker safety, including work controls, worker training, and worker briefing of health and safety requirements; engineering controls consisting of signage located at the RAOU LUC boundaries to discourage unauthorized entry and uses; and SRS access controls to prevent exposure to trespassers, including a 24-hour surveillance system, control entry systems, and warning signs in place at the SRS boundary. The Land Use Control Implementation Plan for RAOU governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (SRNS 2010b). All LUC objectives are being met.

For groundwater contaminated with VOCs and tritium, MNA is the selected remedy. The last two Effectiveness Monitoring Reports were reviewed to support this assessment (SRNS 2014, SRNS 2015). This remedy continues to be an effective remedy based on the following:

- Per the EMP (SRNS 2010c), groundwater monitoring takes place annually at thirty-three wells and nine surface water/seep locations for the RAGW (Figure H-6). These stations monitor four contaminant plumes (one VOC and three tritium). Source well concentrations are decreasing, no exceedances of the source well action limits have ever occurred. Surface water concentrations in 2014 were non-detect for VOCs, and well below the MCL (20 ρCi/ml) for tritium (maximum value in 2014 was 1.82 ρCi/ml). The results indicate that the plumes are still on track to be below MCLs in the time frames predicted.

- A new boundary well was added in 2014 to monitor the eastern VOC plume in the deeper aquifer. Results for TCE from this well are below 1 μg/L, indicating limited migration of the TCE plume.

- As discussed earlier, LUCs are preventing any human health exposure to contaminated groundwater.

Overall the early remedial actions, removal actions, and final remedial action are meeting the RAOs established for the RAOU, as discussed in Section IV, by eliminating or controlling all routes of exposure to residual radioactive or chemical contamination to the industrial worker, eliminating water flow through the R-Area PSLs, preventing the migration of VOCs from the vadose zone to the groundwater, preventing the exposure of contaminated media or structures to residential receptors, and demonstrating that the plume concentrations are trending downward without impact to surface water.

**Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?**

The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy.

Appendix B provides an evaluation of changes in standards and toxicity for chemical and radiological constituents since the last five-year remedy review was initiated in 2012. There have been no significant changes to the 2015 preliminary remedial goal (PRG) and regional screening level (RSL) values that would impact the protectiveness of the remedy.

For the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned Subunit, excavation of highly contaminated media followed by application of clean soil to grade eliminates exposure of human receptors to remaining soil contaminants left in place. Similarly, installation of a soil cover eliminates the human health exposure pathway at the R-Area Ash Basin subunit. Exposure to contamination left in place at the R-Reactor Building (105-R) Complex has been eliminated by the ISD remedy as well as grouting the points of access at the R-Area PSL subunit. There have been no changes in the MCL for tritium that is part of the MNA remedy. Finally, there have been no significant changes to the 2015 PRG and RSL values that would impact the LUCs that are in place to prevent exposure to contaminated media at the RAOU.

Due to the presence of chlorinated solvents at the site, there is a potential that 1,4-dioxane may also exist in groundwater because it is often added to chlorinated solvents as a stabilizer and corrosion inhibitor. SRS reviewed 2010 historical data for 1,4-dioxane from twelve surface water samples collected at the R-Reactor Discharge Canal, Joyce Branch and Pond A. All results were below the detection limit. However, no groundwater samples were analyzed as part of the 2010 sampling effort. To address this concern, groundwater samples collected during the fourth quarter of 2015 will include the 1,4-dioxane analysis. The 1,4-dioxane results will be reported in the subsequent annual groundwater monitoring report, as well as summarized in the next Five-Year Remedy Review for the RAOU. The presence of 1,4-dioxane is not likely to change the protectiveness of the remedial action because LUCs (at a minimum) prevent exposure to contaminated groundwater media.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No new information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

Issues related to the RAOU are presented in Table H-5.

## IX. Recommendations and Follow-up Actions

Recommendations and follow-up actions for the RAOU are presented in Table H-6.

## X. Protectiveness Statement(s)

The remedy is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated groundwater and soil media. All threats to contaminated soil at the RAOU have been addressed through implementation of soil covers, ISD, physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the RAOU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater Remedies is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2009a. *RCRA Facility Investigation / Remedial Investigation (RFI/RI) Report with Baseline Risk Assessment and Corrective Measures Study / Feasibility Study (CMS/FS) for R-Area Operable Unit (U),* WSRC-RP-2008-4035, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009b. *Early Action Record of Decision Remedial Alternative Selection for the C-, K-, L-, and R-Reactor Complexes (U),* SRNS-RP-2009-00707, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009c. *Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (U),* WSRC-RP-2008-4090, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2009d. *Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the R-Reactor Building (105-R) Complex (U)*, SRNS-RP-2009-00801, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010a. *Record of Decision Remedial Alternative Selection for the R-Area Operable Unit (RAOU) (U)*, SRNS-RP-2010-01062, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010b. *Land Use Control Implementation Plan (LUCIP) for the R-Area Operable Unit (RAOU) (U)*, SRNS-RP-2010-01208, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010c. *Effectiveness Monitoring Plan for the R-Area Operable Unit (U)*, SRNS-RP-2010-01259, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010d. *Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the P-Area Ash Basin (Including Outfall P-007) (188-P) and the R-Area Ash Basin (188-R) (U)*, SRNS-RP-2009-01064, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010e. *Removal Site Evaluation Report / Engineering Evaluation / Cost Analysis (RSER/EE/CA) for the R-Area Operable Unit (RAOU) R-Area Process Sewer Line (RPSL) Combined Subunit (NBN) (U)*, SRNS-RP-2009-01341, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010f. *Decommissioning Project Final Report 151-1R, Primary Substation (High Volt 11KV5/13.8KV)*, V-PCOR-R-00016, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *Post Construction Report (PCR) for the R-Area Operable Unit (U)*, SRNS-RP-2011-01574, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *R-Area Groundwater (NBN) Effectiveness Monitoring Report Submittal in Support of R Area Operable Unit (U)*, January 2014 through December 2014, SRNS-RP-

2014-00455, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2015. *R-Area Groundwater (NBN) Effectiveness Monitoring Report Submittal in Support of R Area Operable Unit (U)*, January 2014 through December 2014, SRNS-RP-2015-00343, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, *Stakeholder Recommendations for SRS Land and Facilities*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

USDOE, 2002. Engineering Evaluation/Cost Analysis for the Grouting of the R-Reactor Disassembly Basin at the Savannah River Site, DOE/EE/CA-0001, U.S. Department of Energy, Savannah River Operations Office

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, latest revision, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

Various – Inspection Data Sheets – *Field Inspection Checklists for the R-Area Operable Unit Ash Basin 188-R*, ER-IDS-019-051, Inspections conducted 2012 through 2015 (annually)

Various – Inspection Data Sheets – *Field Inspection Checklists for the R-Area Operable Unit (RAOU)*, ER-IDS-019-064, Inspections conducted 2012 through 2015 (annually)

Various – Inspection Data Sheets – *Field Inspection Checklists for the R-Area Operable Unit Reactor Building and Disassembly Basin*, ER-IDS-019-063, Inspections conducted 2012 through 2015 (annually)

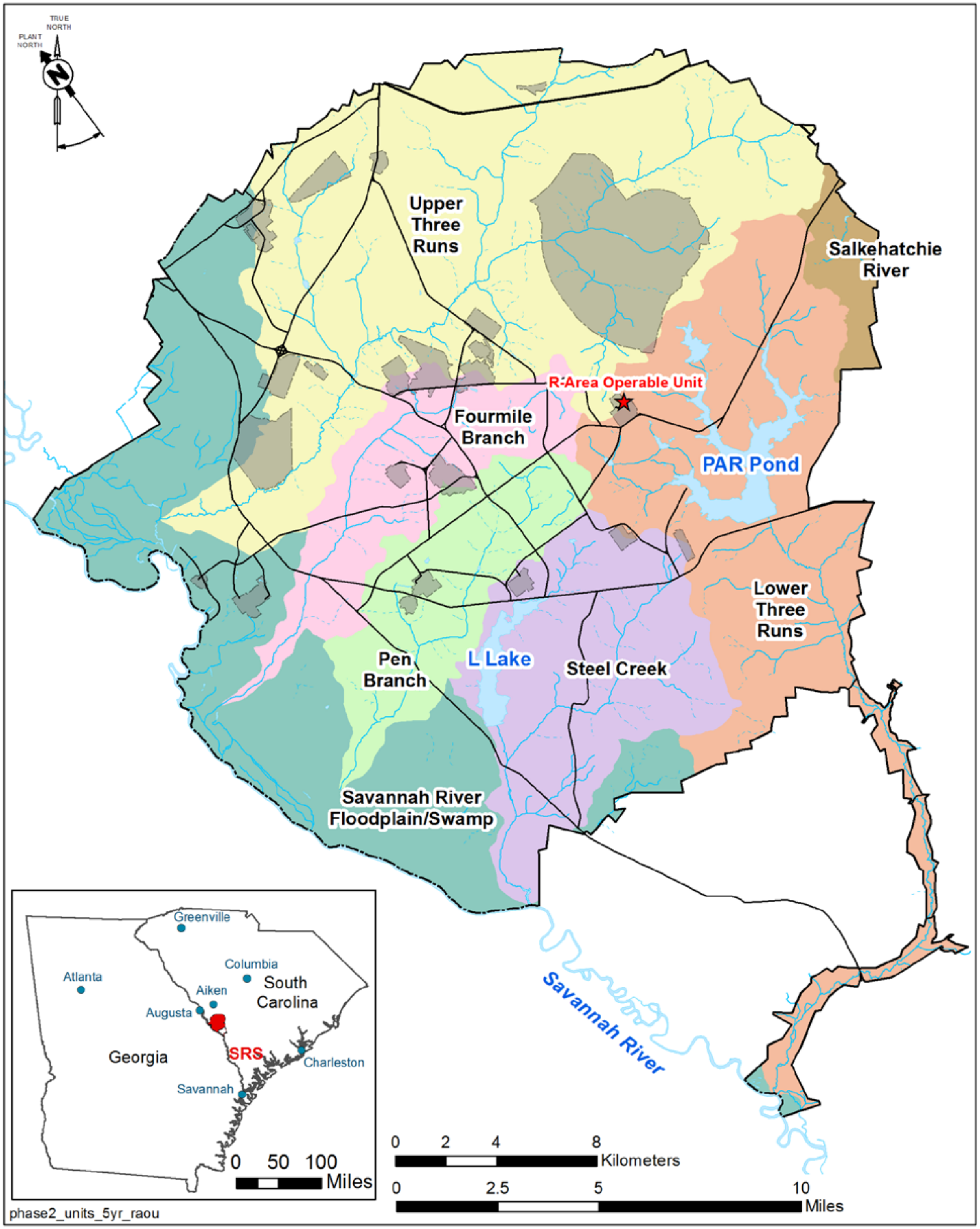


**Figure H-1. Location of RAOU at Savannah River Site**

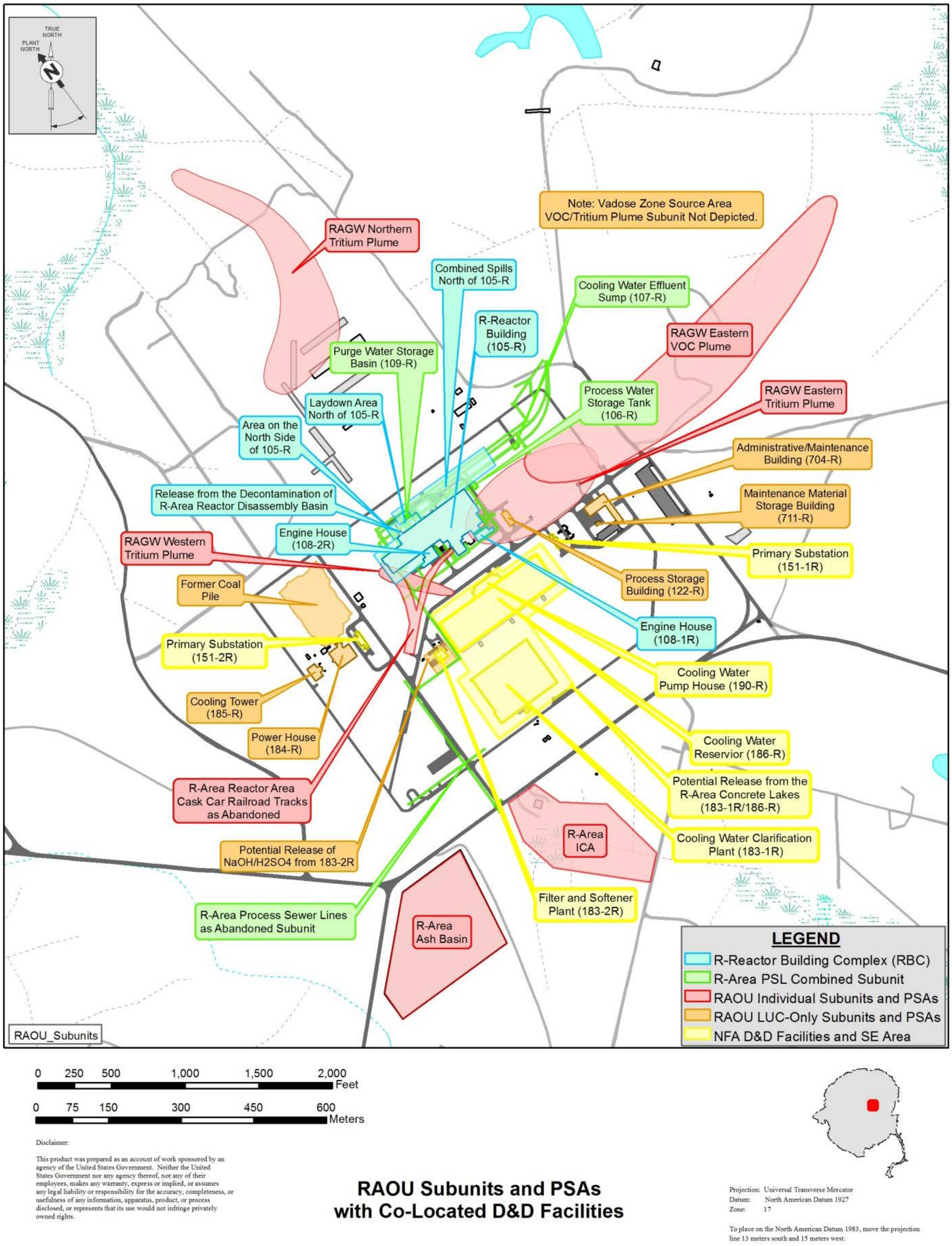


**Figure H-2. Location of RAOU Subunits**


**Figure H-3. Photo of RAOU before Remediation Activities (1999)**


**Figure H-4. Current Photos of RAOU (2015)**

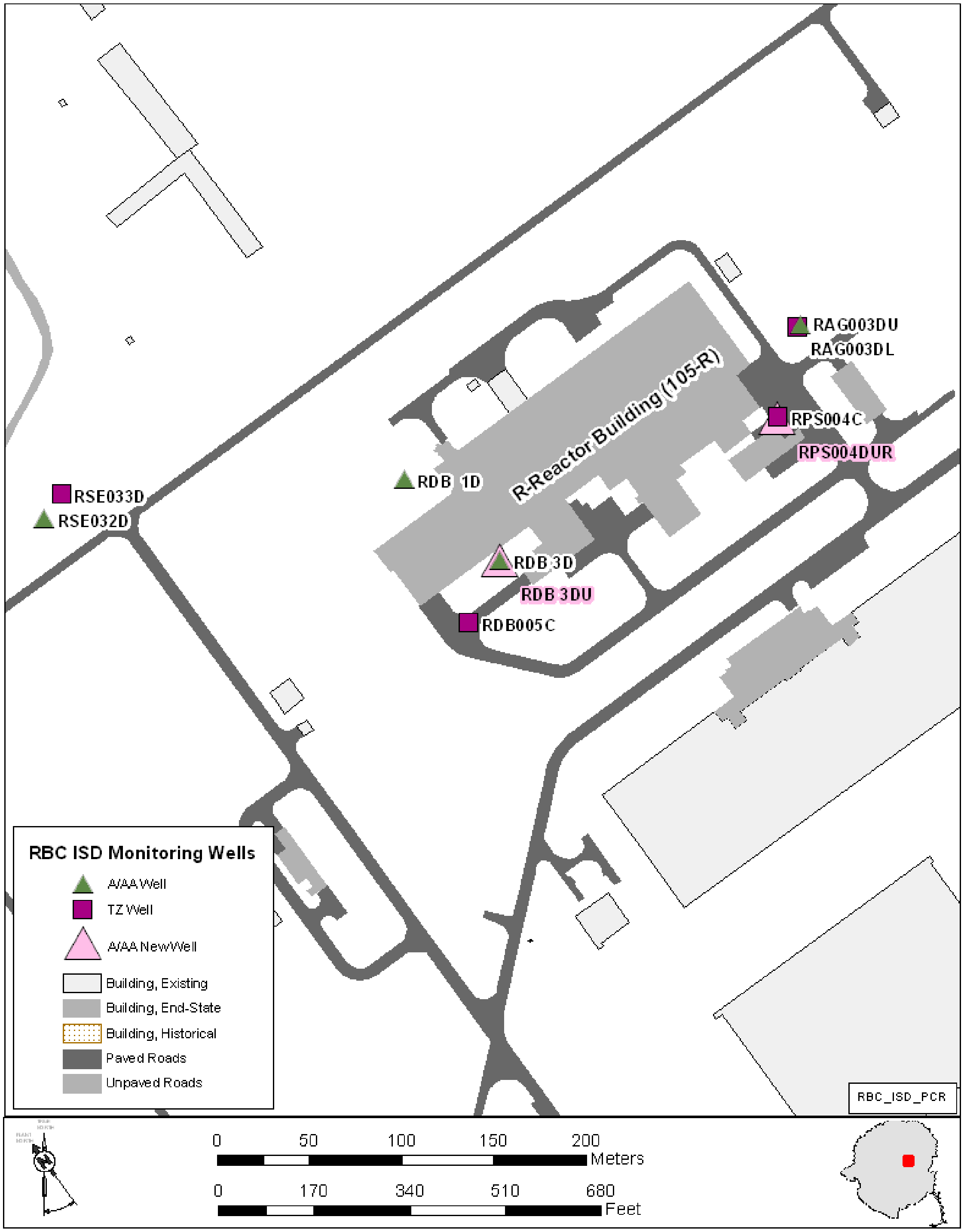


**Figure H-5. ISD Monitoring Stations for R-Reactor Building Complex**

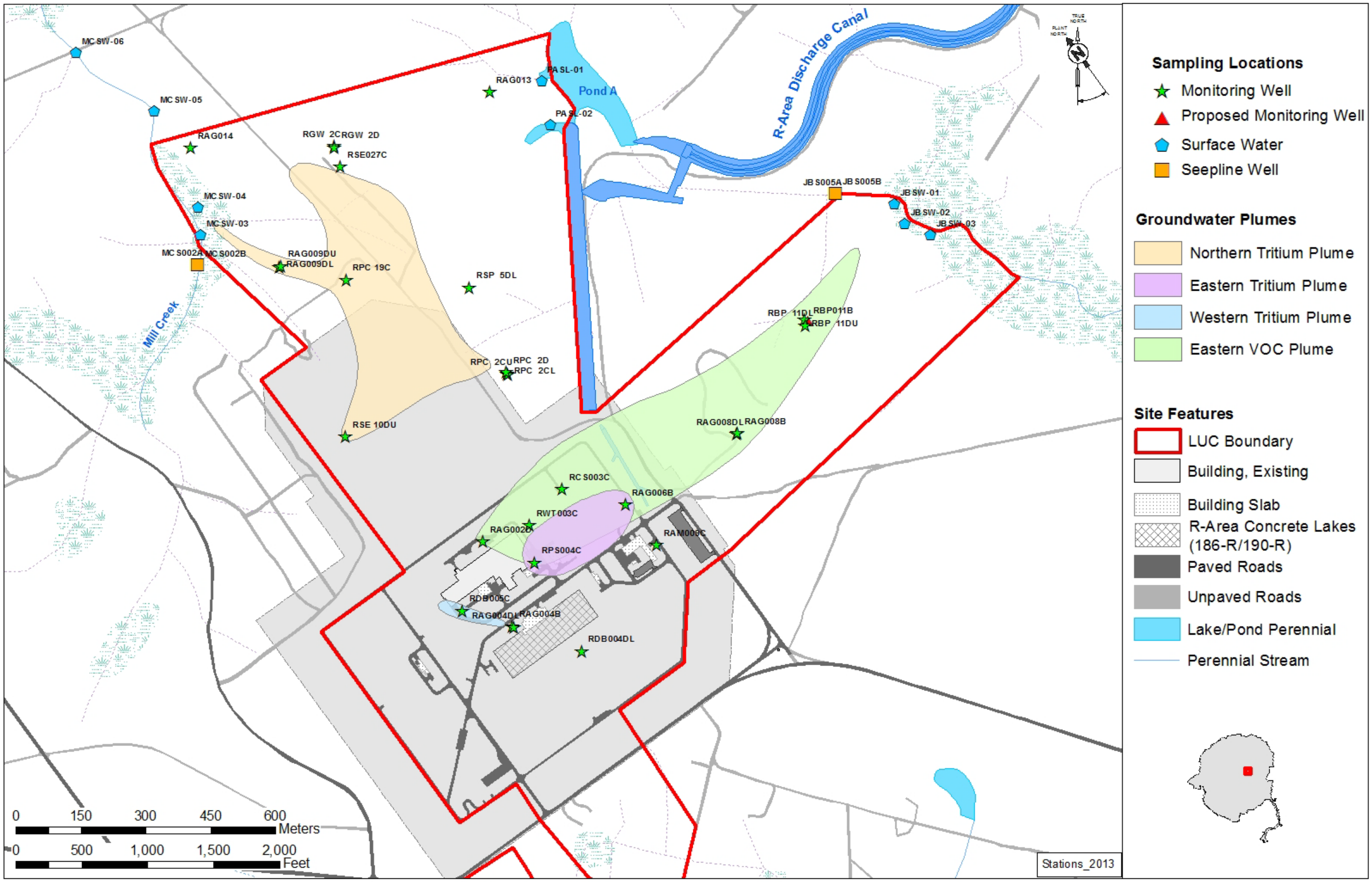


**Figure H-6. MNA Monitoring Stations for RAGW Plumes**

**Table H-1. Chronology of OU Events**

| Event | Date |
|---|---|
| Early Action R-Reactor Disassembly Basin Grouting Start / Finish | October 1, 2002 / April 29, 2003 |
| Early Action R-Reactor Disassembly Basin (Forced Evaporation and Grouting) Start / Finish | April 29, 2003 / November 30, 2010 |
| Issue Early Action ROD for the C-, K-, L-, and R-Rx Complexes | December 8, 2009 |
| Issue Record of Decision Remedial Alternative Selection for RAOU | April 20, 2011 |
| Remedial Action Start / Finish | May 25, 2011 / September 22, 2011 |
| Final Regulatory Walk down – LUCIP and EMP Implementation | September 22, 2011 |
| Previous Five-Year Reviews | February 4, 2014 |

**Table H-2. RAGW and R-Reactor Building (105-R) Complex ISD Groundwater Monitoring RGs**

| RAGW Refined COCs | 2014 Maximum Concentration | RG (MCL) | Units |
|---|---|---|---|
| Tritium | 795 | 20 | ρCi/mL |
| TCE | 12.0 | 5 | μg/L |
| Cis-1,2-Dichloroethylene | 17.0 | 70 | μg/L |
| Vinyl Chloride | 3.2 | 2 | μg/L |
| Carbon Tetrachloride | All Results < Detection Limit | 5 | μg/L |
| Chloroform | 1.5 | 70 | μg/L |
| **R-Reactor Building Complex ISD Refined Contaminant Migration COCs** | **2012 Maximum Concentration** | **RG (MCL or PRG)** | **Units** |
| Carbon-14 | All Results < Detection Limit | 2,000 | ρCi/L |
| Chlorine-36 | All Results < Detection Limit | 700 | ρCi/L |
| Iodine-129 | All Results < Detection Limit | 1 | ρCi/L |
| Lead | 25.40 [A] | 15.0 | μg/L |
| Molybdenum-93 | All Results < Detection Limit | 15.8[B] | ρCi/L |
| Nickel-59 | All Results < Detection Limit | 300 | ρCi/L |
| Niobium-94 | All Results < Detection Limit | 6.81[B] | ρCi/L |
| Potassium-40 | All Results < Detection Limit | 2.14[B] | ρCi/L |
| PCBs | All Results < Detection Limit | 0.5 | μg/L |
| Silver-108m | All Results < Detection Limit | 6.5[B] | ρCi/L |
| Tritium | 1,650 [C] | 20 | ρCi/mL |

NOTES:
A = Consistent with historical data for ISD well RDB 1D: lead value of 24.1 μg/L on 9/21/03.
B = EPA Preliminary Remediation Goal (PRG) for Radionuclides Residential Tap Water (August 2010).
C = Consistent with historical data for ISD well RPS004C: tritium value of 1,740 ρCi/mL on 3/19/08.
COC = Constituent of Concern

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## Table H-3. RAOU RCOCs and RGs

| RAOU Subunit or PSA | | RCOC | Human Health (HH) | Ecological | PTSM | CM | RG | Units | RG Source |
|---|---|---|---|---|---|---|---|---|---|
| R-Reactor Building (105-R) Complex | R Reactor Building (105-R) and Engine Houses (108-1R and 108-2R) | Arsenic | X | | | | 1.59 | mg/kg | PRG |
| | | Aroclor 1254 | X | | | X | 0.5 | µg/L | MCL |
| | | Americium-241 (+D) | X | | | | 7.76 | ρCi/g | PRG |
| | | Americium-243 (+D) | X | | | | 0.344 | ρCi/g | PRG |
| | | Cesium-137 (+D) | X | | X | | 0.113 | ρCi/g | PRG |
| | | Cobalt-60 | X | | X | | 0.0602 | ρCi/g | PRG |
| | | Lead | | | | X | 15 | µg/L | MCL |
| | | Strontium-90 (+D) | X | | | | 14.3 | ρCi/g | PRG |
| | R-Area Disassembly Basin[1] | Cesium-137 (+D) | X | | X | | 0.113 | ρCi/g | PRG |
| | | Cobalt-60 | X | | X | | 0.0602 | ρCi/g | PRG |
| | | Europium-154 | X | | X | | 0.085 | ρCi/g | PRG |
| | | Tritium | X | | X | | 4.23 | ρCi/g | PRG |
| | R-Reactor Emergency Basin | Iodine-129 | | | | X | 1 | ρCi/L | MCL |
| | R-Reactor Vessel[1] | Barium-133 | X | | X | | 0.306 | ρCi/g | PRG |
| | | Cesium-137 | X | | X | | 0.113 | ρCi/g | PRG |
| | | Chlorine-36 | | | | X | 700 | ρCi/L | MCL |
| | | Cobalt-60 | X | | X | | 0.0602 | ρCi/g | PRG |
| | | Europium-152 | X | | X | | 0.0737 | ρCi/g | PRG |
| | | Lead | | | | X | 15 | µg/L | MCL |
| | | Molybdenum-93 | | | | X | 14.2 | ρCi/L | PRG |
| | | Nickel-59 | | | | X | 300 | ρCi/L | MCL |
| | | Nickel-63 | X | | X | | 55,500 | ρCi/g | PRG |
| | | Niobium-94 | X | | X | X | 6.13 | ρCi/L | PRG |
| | | Potssium-40 | | | | X | 1.93 | ρCi/L | PRG |
| | | Silver-108m | X | | X | | 0.0326 | ρCi/g | PRG |
| Area on North Side of Building 105-R, Laydown Area North of 105-R, and Combined Spills North of Building 105-R (NBN), and Release from the Decontamination of R- Area Reactor Disassembly Basin (NBN), and Potential Release from the R-Area Disassembly Basin Subunits | | Cesium-137 (+D) | X | | | | 10 | ρCi/g | Other[2] |
| R-Area Process Sewer Lines as Abandoned (NBN) Subunit | | Radionuclides[3] | X | | X | | NA | ρCi/g | PRG |

## Table H-3. RAOU RCOCs and RGs (continued/end)

| RAOU Subunit or PSA | RCOC | Human Health (HH) | Ecological | PTSM | CM | RG | Units | RG Source |
|---|---|---|---|---|---|---|---|---|
| R-Area Reactor Area Cask Car Railroad Tracks as Abandoned (NBN) Subunit | Cesium-137 (+D), | X | | X | | 10 | ρCi/g | Other[2] |
| | Uranium-235 (+D) | X | | | | 0.394 | ρCi/g | PRG |
| R-Area Ash Basin (188-R) Subunit | Arsenic | X | | | | 1.59 | mg/kg | PRG |
| | Potassium-40 | X | | | | 0.271 | ρCi/g | PRG |
| | Radium-226 (+D) | X | | | | 0.0255 | ρCi/g | PRG |
| | Uranium-235 (+D) | X | | | | 0.394 | ρCi/g | PRG |
| | Uranium-238 (+D) | X | | | | 1.79 | ρCi/g | PRG |
| R-Area Reactor Groundwater Subunit[4] | Trichloroethylene | X | | | | 5 | μg/L | MCL |
| | cis-1,2-Dichloroethylene | X | | | | 70 | μg/L | MCL |
| | Vinyl chloride | X | | | | 2 | μg/L | MCL |
| | Carbon tetrachloride | X | | | | 5 | μg/L | MCL |
| | Chloroform | X | | | | 70 | μg/L | MCL |
| | Tritium | X | | | | 20 | ρCi/mL | MCL |
| R-Area Isolated Contamination Area PSA | Arsenic | X | | | | 1.59 | mg/kg | PRG |
| | Cesium-137 (+D) | X | | | | 0.112 | ρCi/g | PRG |
| | Cobalt-60 | X | | | | 0.0596 | ρCi/g | PRG |
| | Potassium-40 | X | | | | 0.271 | ρCi/g | PRG |
| | Radium-226 (+D) | X | | | | 0.0255 | ρCi/g | PRG |

1. The HRA and PTSM discussions identify several radiological and hazardous constituents as H RCOCs or PTSM, but only the major risk drivers for the individual subunits are presented in this table.
2. A concentration of 10 ρCi/g and LUCs established as RG based on Core Team agreement.
3. Radiological constituents are qualitatively identified as HH and PTSM RCOCs based on process history and the potential for fixed residual contamination on the inside surfaces of the R-Area Process Sewer Lines as Abandoned (NBN).
4. These are based on MCLs rather than a HRA evaluation. Only the constituents forming plumes are listed in Table H-3.

MCL = Maximum Contaminant Level.
PRG = Preliminary Remediation Goal.
NA = Not Applicable.
RG = Remedial Goal.
CM = Contaminant Migration.
PTSM = Principal Threat Source Material.

**Table H-4. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs ($) | 196,220 | 209887 | 264978 | 307347 | 978432 |
| Total ROD Estimated Direct O&M Costs ($) | 62,300 | 47,300 | 47,300 | 47,300 | 204,200 |

[1]FY12 estimated costs include costs associated with the fourth five-year remedy review.

**Table H-5. Issues Identified for RAOU**

| Issue | Currently Affects Protectiveness (Y/N) | Affects Future Protectiveness (Y/N) |
|---|---|---|
| 1,4-Dioxane has been identified as being a potential contaminant at RAOU based on its possible association with other solvents that are present at RAOU. However, there is a lack of groundwater data to dismiss 1,4-dioxane as being present at levels which would be harmful to human health or the environment. | N | N |

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**Table H-6. Recommendations and Follow-up Actions for RAOU**

| Issue | Recommendations/ Follow-up Actions | Party Responsible | Oversight Agency | Milestone Date | Affects Protectiveness? (Y/N) | |
|---|---|---|---|---|---|---|
| | | | | | Current | Future |
| 1,4-Dioxane has not been monitored recently in the RAOU wells. | 1,4-Dioxane will be monitored in all of the RAOU wells sampled for VOCs during the 4Q2015 sampling event. The data results will be presented in the subsequent annual groundwater report that will be submitted in June 2016, as well as in the next Five-Year Remedy Review. Based on the results, the USEPA, SCDHEC and USDOE will decide whether or not 1,4-dioxane should be permanently added to the list of monitored constituents. | USDOE | SCDHEC/ USEPA | June 2016 | N | N |

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## Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit

**I. SITE INFORMATION**

| | | | |
|---|---|---|---|
| **Site Name:** | **R-Area Operable Unit** | **Date of Inspection:** | **07/23/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS # 95** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **91°F and clear** |

**Remedy Includes:** *(Click all that apply)*

- ☒ Landfill Cover/Containment
- ☒ Access Controls
- ☒ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☒ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☒ Other ISD by grouting, grouting R-Area PSLs, forced evaporation

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

**II. INTERVIEWS** *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 7/15/2015 (Date)

   **Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

   **Problems/Suggestions:** ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) EC&ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 7/15/2015 (Date)

   **Interviewed:** ☒ At Site ☐ At Office ☐ By Phone Phone No.: 803-952-4416

   **Problems/Suggestions:** ☐ Report Attached

**Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)***

**II. INTERVIEWS** *(Click all that apply)(Continued)*

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ____________ (Name) ____________ (Title) ________ (Date) ________ (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

4. **Other Interviews** *(Optional):* ☐ Report Attached ______________________

______________________

______________________

______________________

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☐ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☐ N/A |

Remarks: See *Waste Unit Inspection and Maintenance*, ER-SOP-019, *Field Inspection Checklist for RAOU Ash Basin 188-R*, ER-IDS-019-051, *Field Inspection Checklist for the RAOU Reactor Building and Disassembly Basin*, ER-IDS-019-063, and *Field Inspection Checklist for R-Area Operable Unit*, ER-IDS-019-064.

**Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)***

**III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)***

**2. Health and Safety Plans (HASPs):**

- ☐ Site-Specific Health and Safety Plans — ☐ Readily Available ☐ Up to Date ☒ N/A
- ☐ Contingency Plan/Emergency Response Plan — ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER

**3. O&M and OSHA Training Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks: Training Records are complete and up to date per ACP training matrix.

**4. Permits and Service Agreements:**

- ☐ Air Discharge Permit — ☐ Readily Available ☐ Up to Date ☒ N/A
- ☐ Effluent Discharge — ☐ Readily Available ☐ Up to Date ☒ N/A
- ☐ Waste Disposal; POTW — ☐ Readily Available ☐ Up to Date ☒ N/A
- ☐ Other Permits — ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**5. Gas Generation Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**6. Settlement Monument Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**7. Groundwater Monitoring Records:** ☒ Readily Available ☒ Up to Date ☐ N/A

Remarks:

**8. Leachate Extraction Records:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**9. Discharge Compliance Records:**

- ☐ Air — ☐ Readily Available ☐ Up to Date ☒ N/A
- ☐ Water (Effluent) — ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**10. Daily Access/Security Logs:** ☐ Readily Available ☐ Up to Date ☒ N/A

Remarks:

**Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

**Total annual cost by year for review period, if available**

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

From:______ To:______ ______ ☐ Breakdown attached
(Date) (Date) (Total Cost)

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☒ Applicable ☐ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A
Remarks:

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☐ N/A
Remarks: Signs at this site are in good condition.

**Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)***

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Walkdown
Frequency: Annual
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) RCRA/Remedial Program Manager (Title) 10/26/15 (Date) 803-952-9333 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

**2. Adequacy:** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: The ICs are adequately maintaining the RAOU protective systems. When maintenance activities are identified during inspections (e.g., woody vegetation removal from the roof), repairs are scheduled and performed.

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)***

| VI. GENERAL SITE CONDITIONS |
|---|
| **A. Roads** ☒ Applicable ☐ N/A |
| **1. Roads damaged:** ☒ Location shown on site map ☒ Roads adequate ☐ N/A<br>Remarks:__________ |
| **B. Other Site Conditions** |
| Remarks:__________<br>.__________ |
| **VII. LANDFILL COVER/CONTAINMENT** ☒ Applicable ☐ N/A |
| **A. Landfill Surface** |
| **1. Settlement** (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident<br>Areal extent__________ Depth__________<br>Remarks:__________ |
| **2. Cracks:** ☐ Location shown on site map ☒ Cracking not evident<br>Lengths__________ Widths__________ Depths__________<br>Remarks:__________ |
| **3. Erosion:** ☐ Location shown on site map ☒ Erosion not evident<br>Areal extent__________ Depth__________<br>Remarks:__________ |
| **4. Holes:** ☐ Location shown on site map ☒ Holes not evident<br>Areal extent__________ Depth__________<br>Remarks:__________ |
| **5. Vegetative Cover:** ☐ Grass ☐ Cover properly established ☐ No signs of stress<br>Areal extent__________ Depth__________<br>Remarks:__________ |

## Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)*

| **VII. LANDFILL COVER/CONTAINMENT *(Continued)*** |
|---|
| **6. Alternative Cover (armored rock, concrete, etc.):** ☒ Applicable ☐ N/A<br>Remarks: Concrete Cover system |
| **7. Bulges:** ☐ Location shown on site map ☒ Bulges not evident<br>Areal extent________ Depth________<br>Remarks: |
| **8. Wet Areas / Water Damage:** ☒ Wet areas/water damage not evident<br>☐ Wet areas ☐ Location shown on site map Areal extent________<br>☐ Ponding ☐ Location shown on site map Areal extent________<br>☐ Seeps ☐ Location shown on site map Areal extent________<br>☐ Soft subgrade ☐ Location shown on site map Areal extent________<br>Remarks: |
| **9. Slope Instability:** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability<br>Areal extent________<br>Remarks: |
| **B. Benches** ☐ Applicable ☒ N/A<br>(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel) |
| **C. Letdown Channels** ☐ Applicable ☒ N/A<br>(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies) |
| **D. Cover Penetrations** ☐ Applicable ☒ N/A |
| **E. Gas Collection and Treatment** ☐ Applicable ☒ N/A |
| **F. Cover Drainage Layer** ☐ Applicable ☒ N/A |
| **G. Detention/Sedimentation Ponds** ☐ Applicable ☒ N/A |
| **H. Retaining Walls** ☐ Applicable ☒ N/A |
| **I. Perimeter Ditches/Offsite Discharge** ☐ Applicable ☒ N/A |

**Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued)***

| |
|---|
| **VIII. VERTICAL BARRIER WALLS** ☐ **Applicable** ☒ **N/A** |
| **IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A |
| **A. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **1. Pumps, Wellhead Plumbing, and Electrical:**<br>☐ Good Condition ☐ All required wells located ☐ Needs Maintenance ☐ N/A<br>Remarks:______ |
| **2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances:**<br>☐ Good Condition ☐ Needs Maintenance<br>Remarks:______ |
| **3. Spare Parts and Equipment:**<br>☐ Readily Available ☐ Good Condition ☐ Requires Upgrade ☐ Needs to be provided<br>Remarks:______ |
| **B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **C. Treatment System** ☐ Applicable ☒ N/A |
| **D. Monitoring Data** ☒ Applicable ☐ N/A |
| **E.** Monitored Natural Attenuation ☒ Applicable ☐ N/A |
| **1. Monitoring Wells** *(natural attenuation remedy)***:**<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition<br>☐ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks:______ |
| **X. OTHER REMEDIES** |
| If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. |
| **A. Soil Vapor Extraction System** ☐ Applicable ☒ N/A |

## Attachment H-1. Five-Year Review Site Inspection Checklist – R-Area Operable Unit *(continued/end)*

### XI. OVERALL OBSERVATIONS

**A. Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

Remedies for this site are removal actions, land use controls and MNA to eliminate or control all routes of exposure to residual radioactive or chemical contamination. All systems appear to be functioning as expected

**B. Adequacy of O&M**

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures are adequately maintaining the MNA system. The O&M procedures consisting of annual site inspections and site maintenance (vegetation removal, structures integrity and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. When maintenance activities are identified during inspections (e.g., woody vegetation removal from the roof), repairs are scheduled and performed. There are no issues requiring corrective actions.

**C. Early Indicators of Potential Remedy Failure**

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

**D. Opportunities for Optimization**

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

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# R-AREA REACTOR SEEPAGE BASINS (904-57G, -58G, -59G, -60G, -103G, -104G) AND 108-4R OVERFLOW BASIN OPERABLE UNIT

## I. Introduction

This report is the third five-year review for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin (RRSB) Operable Unit (OU). The review was conducted from August 2015 through November 2015. Contaminants have been left in place at the RRSB OU at levels that do not allow for unlimited use and unrestricted exposure. The purpose of this review is to determine whether the remedy in place at the RRSB OU is protective of human health and the environment. This report documents the results of the review.

## II. OU Chronology

Table I-1 lists the chronology of site events for the RRSB OU.

## III. Background

RRSB OU is listed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS) (FFA 1993). The media associated with the RRSB OU are soil and groundwater.

The RRSB OU consists of the following: six seepage basins, process sewer lines, sanitary sewer system (sewer lines and sanitary discharge lagoon), an area of contaminated vegetation north of R-Reactor Building (105-R), surface water and sediment, RRSB groundwater, and the 108-4R Overflow Basin.

### Physical Characteristics

R Area is located in the east-central portion of SRS, west of PAR Pond (Figure I-1). The RRSB OU is located north of the R-Reactor Building (105-R) (Figure I-2) and straddles the boundary between the Upper Three Runs and Lower Three Runs watersheds. Prior to initiation of remedial actions, the entire area, 11 hectares (27 acres), was fenced and approximately 45%, 5 hectares (12 acres), was paved.

Six unlined earthen basins were constructed to receive radioactively contaminated purge water from R-Reactor's spent fuel storage process. All six basins were constructed between June 1957 and March 1958. The basins varied in depth from 2 to 4.9 m (6.6 ft to 16.4 ft) below ground surface (bgs). Basin 1 was L-shaped, with each leg approximately 60 m (200 ft) long by 12 m (40 ft) wide. Basin 2 was 60 m (200 ft) long by 15 m (50 ft) wide. Basin 3 was 90 m (300 ft) long by 9 m (30 ft) wide. Basin 4 was 97.5 m (325 ft) long by 9 m (30 ft) wide. Basin 5 was 112.5 m (375 ft) long by 12 m (40 ft) wide. Basin 6 was 165 m (550 ft) long by 15 m (50 ft) wide (WSRC 1997).

Process sewer lines conveyed process water from the R-Reactor disassembly basin to the six seepage basins. The pipelines to Basins 1 through 5 were 7.5-cm (3-in) polyvinyl chloride (554 m [1,848 ft] in total length) and the pipeline to Basin 6 was 10-cm (4-in) steel (340.5 m [1,135 ft] in total length) (WSRC 1997).

A 15-cm (6-in) and 30-cm (12-in) terra cotta sanitary sewer line that supported a housing camp during construction of the R-Reactor extended through the RRSB OU to convey wastewater to a sanitary discharge lagoon (WSRC 1997).

Three small surface areas, called the eastern, western, and northern contamination areas, were contaminated near the basins ranging in size respectively [6 x 12 m (20 x 40 ft), 4.5 x 9 m (15 x 30 ft), and 3.6 x 4.5 m (12 x 15 ft)] (SRNS 2008).

The 108-4R Overflow Basin is located 75 m (250 ft) southwest of the R-Reactor and approximately 150 m (500 ft) southwest of R-Reactor Seepage Basins. The basin was constructed to collect overflow from two adjacent underground storage tanks (USTs) within a vault (108-3R) that stored diesel fuel for standby generators in the R Reactor. The unlined basin was approximately 60 feet x 60 feet x 8 feet deep. A soil berm up to 0.6 m (2 ft) above grade was placed around the basin's perimeter. The USTs were removed in March 1990 and the associated piping was abandoned in place after being flushed and purged as directed by South Carolina Department of Health and Environmental Control (SCDHEC).

The RRSBs lie north of and adjacent to R-Reactor on an elevated divide between Mill Creek and the primary discharge canal northeast of the R-Area perimeter fence (Figure I-2). The OU is situated between drainage to PAR Pond located 2.7 km (1.7 mi) to the southeast (beyond the boundaries of the figure) and the headwaters of Mill Creek located 0.4 km (0.25 mi) to the northwest. The western edge of the basin area slopes towards the west. Surface water drainage from the RRSB OU flows north and west into Mill Creek or east into the R-Area Discharge Canal and Pond A.

Groundwater in the shallow water table aquifer, a horizon of the Upper Aquifer Zone of the Upper Three Runs Aquifer, has been contaminated. Historically, large fluctuations in the water table elevation occur as a result of changes in precipitation, resulting in occurrences of groundwater coming close to or in contact with contamination in the bottom of the basins. Groundwater flow is primarily vertical from the A to AA horizon to the Transmissive Zone, where flow becomes more lateral moves radially away from the basins. A review of water table elevations from the currently monitored wells over the last five years indicate increasing levels through early 2010, with falling levels consistent with decreased rainfall since then.

**Land and Resource Use**

According to the *Savannah River Site Future Use Project Report* (USDOE 1996), residential uses of the SRS land should be prohibited. The *Land Use Control Assurance Plan for the Savannah River Site* (WSRC 1999) designates RRSB OU as being within the site industrial support area. The future land use for RRSB OU is reasonably anticipated to remain industrial with the U.S Department of Energy (USDOE) maintaining control of the land.

**History of Contamination**

The six basins received an estimated 5-million gallons of purge water, containing approximately 3,276 curies (Ci) total activity, from the R-Reactor disassembly basin. Primary radionuclides present were strontium-90 and cesium-137. A non-routine discharge, due to a calorimeter test failure in 1957, released approximately 2,700 Ci of radionuclides primarily to Basin 1 with Basins 2 through 5 receiving a lesser amount. A sanitary sewer system was breached during the construction of Basins 1 and 5 and received the contaminated water discharged to the basins (WSRC 1997).

Basins 1 through 5 were retired and backfilled during the period 1958 through 1959. The backfill operation involved placement of clean soil followed by a cover of a thin asphalt emulsion to restrict the infiltration of surface water and to inhibit the growth of vegetation. Between 1960 and 1963, clay dikes were placed around Basin 1 and the northwest end of Basin 3. The dikes extended down to a clay layer at an approximate depth of 4.5 m (15 ft) and 2.4 m (8 ft) at Basins 1 and 3, respectively. Clay caps were then placed over the diked areas to control exposure to radioactively contaminated surface soils and infiltration of surface water (WSRC 1997). Basin 6 was retired in 1964, when operations at R-Reactor ceased. In 1977, this basin was backfilled with soil and covered with a thin asphalt emulsion (WSRC 1997).

In 1996, the asphalt emulsion over all the basins was determined to be contaminated with radioactive soil, vegetation, and fire ant mounds. The surface contamination was being spread by surface water runoff and wind (WSRC 1997). Figure I-3 shows a photograph of one of the basins prior to any remedial action.

The 108-4R Overflow Basin was in operation from 1953 to 1964. The USTs were removed in March 1990, and associated piping was abandoned in place after being flushed and purged to less than 20 percent of the lower explosive limit as directed by SCDHEC. Soil and groundwater samples taken during excavation of the USTs indicated no detectable levels of contamination. The groundwater samples were collected from groundwater that seeped into the excavation (WSRC 1990).

**Initial Response**

The *Removal Site Evaluation Report for the R-Reactor Seepage Basin, Erosion Control Activities and Asphalt Cover Refurbishment* (WSRC 1996), determined that the spread of contamination due to the deteriorated condition of the asphalt emulsion cover warranted action. A removal action was performed during the summer of 1996, which included a

4.34-hectare (10.7-acre) cover system over the existing asphalt emulsion. The cover system consisted of a 10-cm (4-inch) thick layer of asphalt over 0.45 m (1.5 ft) minimum thick layer of clean soil. Prior to the cover system installation, the surfaces of the basins were treated with herbicides and insecticides, and the surface was recontoured to promote drainage.

**Basis for Taking Action**

Because of the large quantity of radioactivity in the historical releases, it was concluded that the subsurface soil associated with the basin bottoms, the process sewer lines, and the contaminated sections of the sanitary sewer line should be considered principal threat source material (PTSM). Final contaminants of concern (COCs) and associated remedial goals (RGs) were developed for the RRSB (WSRC 2002, 2003) (Table I-2).

The 108-4R Overflow Basin, Surface Water, and Sediment subunits were characterized under a separate soil investigation from February to April 1996. No final COCs were identified for soil or groundwater. Therefore, there is no problem warranting action at the 108-4R Overflow Basin, surface water, and sediment. With approval of SCDHEC and US Environmental Protection Agency (USEPA), this subunit was backfilled and covered by a vegetative layer.

The basis for taking action was due to potential exposure of residents or industrial workers to unacceptable levels of carcinogenic contaminants in soils and groundwater, and due to the potential continuing impact to groundwater due to leaching from contaminated soils. Risks were highest for exposures to soils attributable to the presence of multiple radionuclides, including cesium-137 and strontium-90. Potential risks associated with exposure to groundwater are attributed to the presence of strontium-90. No ecological risks were associated with this OU.

# IV. Remedial Actions

## Remedy Selection

As stated in the Record of Decision (ROD) (WSRC 2003), the selected remedial action for the RRSB OU is placement of a reinforced concrete intruder barrier system with granite monuments over the PTSM, excavation of PTSM outside of the boundary fence and disposal on-unit, excavation and on-unit disposal of contaminated vegetation, installation of an asphalt bioturbation barrier, mixing zone for groundwater, and institutional controls. The RGs for groundwater COCs are based on achieving their respective maximum contaminant level (MCL) values in all monitoring wells.

As stated in the ROD (WSRC 2003), the RAOs for the four RRSB OU subunits that require remedial actions include the following:

***Seepage Basins***

- Minimize transport of soil contaminants to groundwater above MCLs;
- Prevent industrial worker exposure to contamination (including contaminated vegetation) in the long-term;
- Consider treatment or removal to address PTSM to the extent practicable; and
- Prevent residential development within the RRSB OU and any exposure to basin contents.

***Abandoned Process Sewer Lines***

- Prevent industrial worker exposure to the pipelines;
- Consider treatment alternatives to address PTSM (pipelines) to the extent practicable; and
- Prevent residential development within the OU and any exposure to the pipelines.

***Sanitary Sewer System***

- Prevent industrial worker exposure to the sanitary sewer lines and associated subsurface soil contaminants;

- Prevent industrial worker exposure to contaminated vegetation;
- Prevent future transfer of subsurface soil contaminants towards the surface through biotic uptake or bioturbation;
- Consider treatment alternatives to address PTSM (sanitary sewer line) to the extent practicable; and
- Prevent residential development within the OU and any exposure to the sewer lines.

***Groundwater***

- Prevent industrial worker exposure to groundwater contaminated above MCLs.
- Reduce strontium-90 concentrations in groundwater to below MCLs.
- Minimize the spread of groundwater contamination and prevent discharge of contaminated groundwater to surface water; and
- Prevent residential development within the OU and any exposure to contaminated groundwater.

**Remedy Implementation**

Implementation of these remedial actions included the following activities (SRNS 2008):

- Consolidated PTSM in a PTSM Waste Trench, which included excavation of all contaminated process and sanitary sewer lines, and associated soil located outside of the OU boundary, and contaminated soils in the CAs. The PTSM consisted of approximately 230 $m^3$ (300 $yd^3$) of process pipes and associated soil, 54 $m^3$ (70 $yd^3$) of soil from the three CAs, seven 55-gallon drums of solidified residual water collected from the process sewer lines and five thrust blocks (2 x 2 x 2 ft). The CAs were backfilled using adjacent soils (in two CAs) or common fill (in one CA). Where practical, the pipes were grouted prior to removal to contain contaminants. The excavated areas were backfilled with clean fill material.

- Consolidated contaminated trees from the RRSB OU and the Warner's Pond OU, secondary waste and track hoe in areas where contaminated vegetation had grown. The contaminated trees were cut down, chipped, stockpiled, composted, and blended with the first foot of soil where contaminated vegetation had previously grown. The secondary waste consisted of pre-existing concrete markers, galvanized corrugated metal pipe and miscellaneous job control waste and personal protective equipment (PPE).

- Installed a concrete intruder barrier covering 2.2 hectares (5.5 acres) over all PTSM located in all six basins, the PTSM Waste Trench, and the process sewer lines inside the boundary fence (Figures I-2 and I-4). The barrier consisted of a 15-cm (6-in) minimum reinforced concrete placed directly on the existing asphalt cover or over a 15-cm (6-in) minimum thick layer of clean, compacted structural fill on soils and newly placed asphalt. The barrier extended 3 m (10 ft) beyond the edge of the PTSM.

- Installed an asphalt bioturbation barrier covering 5.1 hectares (12.6 acres) where contaminated vegetation had previously grown (Figures I-2 and I-4). The barrier consists of a 10-cm (4-in) minimum thick asphalt layer over a 15-cm (6-in) minimum thick layer of clean, compacted structural fill. The barrier extended 6 m (20 ft) beyond the edge of the area.

- Installed five granite monuments on the concrete intruder barrier to warn future inadvertent intruders.

- Established a mixing zone monitoring well network by installing 15 monitoring wells and abandoning 30 existing monitoring wells.

- Installed 26 Access Control Warning signs and fencing along the perimeter of the RRSB OU.

- Established land use controls (LUCs) for 15.3 hectares (37.8 acres) including: 1) requiring a Site Use and Site Clearance Permit for any proposed use of land within the OU area, which is applicable to all activities and personnel on site; 2) maintaining the site access controls (24-hour surveillance system, artificial and natural barriers, control entry systems, and warning signs) in place at the SRS boundary to comply with the security requirements for a RCRA-permitted facility; and 3) in the long-term, if the property ever is transferred to non-federal 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 (WSRC 2003).

**System Operations/Operation and Maintenance**

There are no system operational requirements.

The following maintenance activities are ongoing:

- Groundwater mixing zone monitoring program has been implemented. Groundwater Mixing Zone Reports were being issued biennially through 2014, with the first report issued in August 2010 (SRNS 2010, SRNS 2012a, SRNS 2014). After 2014, reports are to be issued every four years (2018, 2022, etc.), with letter reports issued in between (2016, 2020, etc.). Groundwater is being monitored for strontium-90 and water elevation.

- Annual site inspections and site maintenance (i.e., intruder and bioturbation barriers maintenance, repair of erosion damage, fencing and warning signs) (WSRC 2008). Minor repairs (e.g., seal small cracks, remove vegetation growth) to the RRSB bioturbation asphalt barrier are completed soon after discovery. Major repairs (e.g., complete asphalt resurfacing) are anticipated approximately every fifth year. Major repairs for the RRSB OU asphalt/concrete intruder barrier was completed during fiscal year 2015. Major repairs included filling of cracks and sealing the entire asphalt bioturbation barrier, replacing several concrete expansion joints and repairing spalled portions of the concrete intruder barrier.

- Site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented.

Costs associated with the selected remedy for RRSB include operation and maintenance (O&M) costs of the cover, groundwater mixing zone monitoring, and institutional controls. The ROD estimated O&M cost, including Five-Year Remedy Review costs, associated with the selected remedy is $19,145,000, which was discounted at 3.9% per year. This is a present worth cost, including 30 years of maintenance activities. The estimated O&M costs applicable to FY2012 through FY2015 are $1,293,326. The actual O&M cost from FY2012 to FY2015 is $616,165. The actual O&M costs (Table I-3) are less than estimated costs due to optimization of the groundwater monitoring. Based on inspections conducted from FY2012 through FY2015, the various maintenance activities completed at RRSB OU included sealing asphalt, removing debris (i.e., pine straw and leaves) from asphalt cover, removing trees from the fence line and fence repair due to damage from 2014 ice storm, applying herbicide to vegetation (i.e., on fence, in expansion joints on cover, and both sediment basins), cutting vegetation in sediment basins, and treating active ant mounds.

## V. Progress Since Last Review

The previous protectiveness statement concluded that the remedial actions at RRSB OU are expected to be protective, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. The final remedial actions were not evaluated in the previous five-year review because the ROD had just been issued. The final remedial actions of excavation, consolidation, and backfilling of excavated areas, constructing intruder and bioturbation barriers followed with groundwater mixing zone and LUCs have now been installed and have been functioning properly.

Several changes to the groundwater monitoring program were proposed in 2012 (SRNS 2012b) and described in the previous Five-Year Review (SRNS 2013). The changes included:

- Deleting americium-241 from the list of monitored analytes;

- Removing one monitoring well that is producing redundant data with another well in close proximity and screened within the same aquifer zone;
- Suspending sampling of boundary wells in the lowest monitored aquifer zones until such time as shallower wells within the flow path have detections of strontium-90;
- Reducing sampling frequency from annual to biennial and reporting frequency from every two years to every fourth year (a letter report will be submitted two years after the full report); and
- Adding five existing wells to the boundary MCL compliance network.

These changes were approved by USEPA and SCDHEC and were implemented beginning in the fourth quarter of 2013 (SRNS 2014).

## VI. Five-Year Review Process

The following tasks were performed as part of the review:

- Reviewed the documents listed in Section XII, Documents Reviewed;
- Evaluated the mixing zone to ensure that the contamination has not migrated beyond its established boundaries and the progress of radioactive decay in bringing contamination below MCLs. This process is calculated to take approximately 300 to 400 years (WSRC 2003);
- Confirmed the implementation of the remedial action;
- Inspected the OU, interviewed maintenance personnel and documented the results on the Inspection Checklist, provided in Attachment I-1 with the purpose of assessing the protectiveness of the remedy and the functionality of the access controls; and
- Reviewed changes in standards and to-be-considered guidance

### *Data Review*

Per the approved RRSB Mixing Zone Application and subsequent modifications (SRNS 2012b) groundwater is monitored for strontium-90 and water elevation.

Figure I-5 presents time trends of strontium-90 for the plume/intermediate wells. Concentrations of strontium-90 in all wells have been below their mixing zone concentration limits since the mixing zone was established in 2007, except for one result at well RSE 10. However, that elevated result is attributed to excessive turbidity in the well.

The boundary well data was reviewed (149 records from 17 wells). There have been no confirmed MCL exceedances for strontium-90 since the previous Five-Year Review. This is consistent with the groundwater modeling predictions and uncertainty analysis that were the basis for the groundwater mixing zone application that predicted the strontium-90 plume to diminish in all horizons within 100 years, be relatively stationary, and not move significantly in any direction (WSRC 2004). The selected remedy of MNA by radioactive decay is effective in reducing strontium-90 concentrations in the groundwater. The mixing zone groundwater data verifies that groundwater does not exceed MCLs at the compliance points (boundary monitoring wells). Per the ROD, the mixing zone is monitored to ensure that the contamination does not migrate beyond its established boundaries and to follow the progress of radioactive decay in bringing contamination to MCLs. This process is calculated to take approximately 300 to 400 years (WSRC 2003).

***Summary of Inspections and Interviews***

Interviews were conducted with Richard Feagin, O&M staff member, on July 15, 2015 at the RRSB OU and with George Joyner, O&M Site Manager, on July 15, 2015 at the O&M organization offices. The RRSB OU was inspected by SRNS and USDOE personnel on July 29, 2015 and October 26, 2015, respectively. No issues were identified for the RRSB OU during this inspection and interviews.

## VII. Technical Assessment

### Is the Remedy Functioning as Intended by the Decision Document?

The review of documents, applicable or relevant and appropriate requirements (ARARs), risk assumptions, and the results of the site inspection indicates that the remedy is functioning as intended by the ROD. The consolidation of PTSM and contaminated trees and materials from RRSB OU and Warner's Pond OU, followed by placement of a concrete intruder barrier over PTSM contaminated materials and process sewer lines within the boundary fence is effective in preventing industrial worker exposure to contamination. This remedy component is minimizing rainwater infiltration, thus preventing the mobilization of CMCOCs to groundwater above MCLs. The remedy component of MNA by radioactive decay is effective in reducing strontium-90 concentrations in the groundwater. The mixing zone groundwater data verifies that groundwater has not exceeded MCLs at the compliance points (boundary monitoring wells). The remedial action has achieved the remedial action objectives (RAOs) for this OU. The effective implementation of institutional controls has prevented exposure to contaminated materials (i.e., soil, pipelines, vegetation) that remain beneath the cover system.

The annual site inspections, site maintenance (i.e., intruder and bioturbation barriers maintenance, repair of erosion damage, fencing and warning signs), and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) currently implemented continue to maintain the effectiveness of response actions. The main finding in the inspection reports has been growth of vegetation on fencing and around survey markers that was remedied by cutting and application of herbicides. Inspection and maintenance data do not indicate a history of problems with the cover systems, which could place protectiveness at risk. No issues were identified that require corrective action.

The LUCs that are in place controls include (1) physical access controls to prevent unauthorized entry to SRS and the OU (fences, guards, security patrols, etc.); (2) administrative controls that maintain the OU for industrial use only (SRS is a secured government facility with land use restrictions); and (3) fencing, warning signs and LUCs (SRS Site Use/Site Clearance Program). The *Land Use Control Implementation Plan for RRSB OU* governs LUC implementation, maintenance, monitoring, reporting, and enforcement of LUCs (WSRC 2008). No activities were observed that would have violated the institutional controls.

**Are Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives still valid?**

The exposure assumptions, toxicity data, and cleanup levels used at the time of remedy selection are still valid. There have been no changes in standards or to-be-considered guidance identified in the ROD that call into question the protectiveness of the remedy. There have been no changes in the physical conditions of the site that would affect the protectiveness of the remedy.

Appendix B provides an evaluation of changes in standards and toxicity for chemical and radiological constituents since the last five-year remedy review was initiated in 2012. There have been no significant changes to the 2015 preliminary remedial goal and regional screening level values that would impact the protectiveness of the remedy.

**Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?**

No other information has come to light that could call into question the protectiveness of the remedy.

## VIII. Issues

There are no issues related to current site conditions or activities that currently prevent the remedy at the RRSB OU from being protective.

## IX. Recommendations and Follow-up Actions

There are no recommendations and follow-up actions concerning RRSB OU

## X. Protectiveness Statements

The remedy is protective of human health and the environment.

Exposure pathways that could result in unacceptable risks are being controlled by institutional controls (i.e., LUCs) to prevent exposure to or ingestion of contaminated groundwater and soil media. All threats to contaminated soil at the RRSB OU have been addressed through excavation, consolidation, and backfilling of excavated areas, and implementation of physical access controls to prevent unauthorized entry to SRS (fences, guards, security patrols, etc.), administrative controls that maintain the RRSB OU for industrial use only, and warning signs and use restrictions via the SRS Site Use/Site Clearance Program. Protectiveness of the remedial action will be verified by continued groundwater monitoring.

## XI. Next Review

The Fifth Five-Year Remedy Review Report and subsequent reports will be segregated into five phases. As shown in Appendix A, Table A-1, the next five-year review for SRS OUs with Groundwater Remedies is scheduled for January 2021.

## XII. Documents Reviewed

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

SRNS, 2008. *Post-Construction Report for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) Operable Unit (U),* WSRC-RP-2005-4070, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2010. *2009 Biennial Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U),* SRNS-RP-2010-00999, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012a. *2011 Biennial Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U),* SRNS-RP-2012-00349, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012b. *EC&ACP Groundwater Monitoring Optimization Report: A Comprehensive, Technical Approach for the Evaluation and Optimization of Groundwater Monitoring and Reporting (U),* SRNS-RP-2012-0196, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2013. *Fourth Five-Year Remedy Review Report (U) Aiken, South Carolina*, SRNS-RP-2012-00011, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2014. *2012/2013 Groundwater Mixing Zone Report for the R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit (U)*, SRNS-RP-2014-00318, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

USDOE, 1996. *Savannah River Site Future Use Project Report*, U.S. Department of Energy, Savannah River Operations Office, Savannah River Site, Aiken, SC

WSRC, 1990. *Site Assessment of the 108-R Underground Storage Tank System at the Savannah River Site*, under cover from J.V. Odum to J.R. Hess (SCDHEC), ESH-FSG-900260, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC.

WSRC, 1996. *Removal Site Evaluation Report for the R Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) Erosion Control Activities and Asphalt Cover Refurbishment (U)*, WSRC-RP-96-141, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 1997. *Preliminary Characterization Report Phase 1 RFI/RI for the R-Reactor Seepage Basins/108-4R Overflow Basin (U)*, WSRC-RP-97-196, Revision 0, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 1999. *Land Use Control Assurance Plan for the Savannah River Site*, WSRC-RP-98-4125, Revision 1.1, latest revision, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

WSRC, 2002. *RCRA Facility Investigation/Remedial Investigation Report with Baseline Risk Assessment for the R-Area Reactor Seepage Basins/ 108-4R Overflow Basin Operable Unit (U)*, WSRC-RP-98-314, Revision 1.2, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2003. *Record of Decision for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit (U)*, WSRC-RP-2003-4093, Revision 1, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2004. *R-Area Reactor Seepage Basins and 108-4R Overflow Basin Operable Unit Mixing Zone (U)*, WSRC-RP-2002-4053, Revision 1.2, Westinghouse Savannah River Company LLC, Savannah River Site, Aiken, SC

WSRC, 2008. *Land Use Control Implementation Plan for the R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) Operable Unit (U),* WSRC-RP-2004-4032, Revision 1.1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

Various - Inspection Data Sheets – *Field Inspection Checklist, R-Reactor Seepage Basins 904-57G, 58G, 59G, 50G, 103G, 104G (U)*, ER-IDS-019-048, Inspection period 2012 through 2015 (annually)

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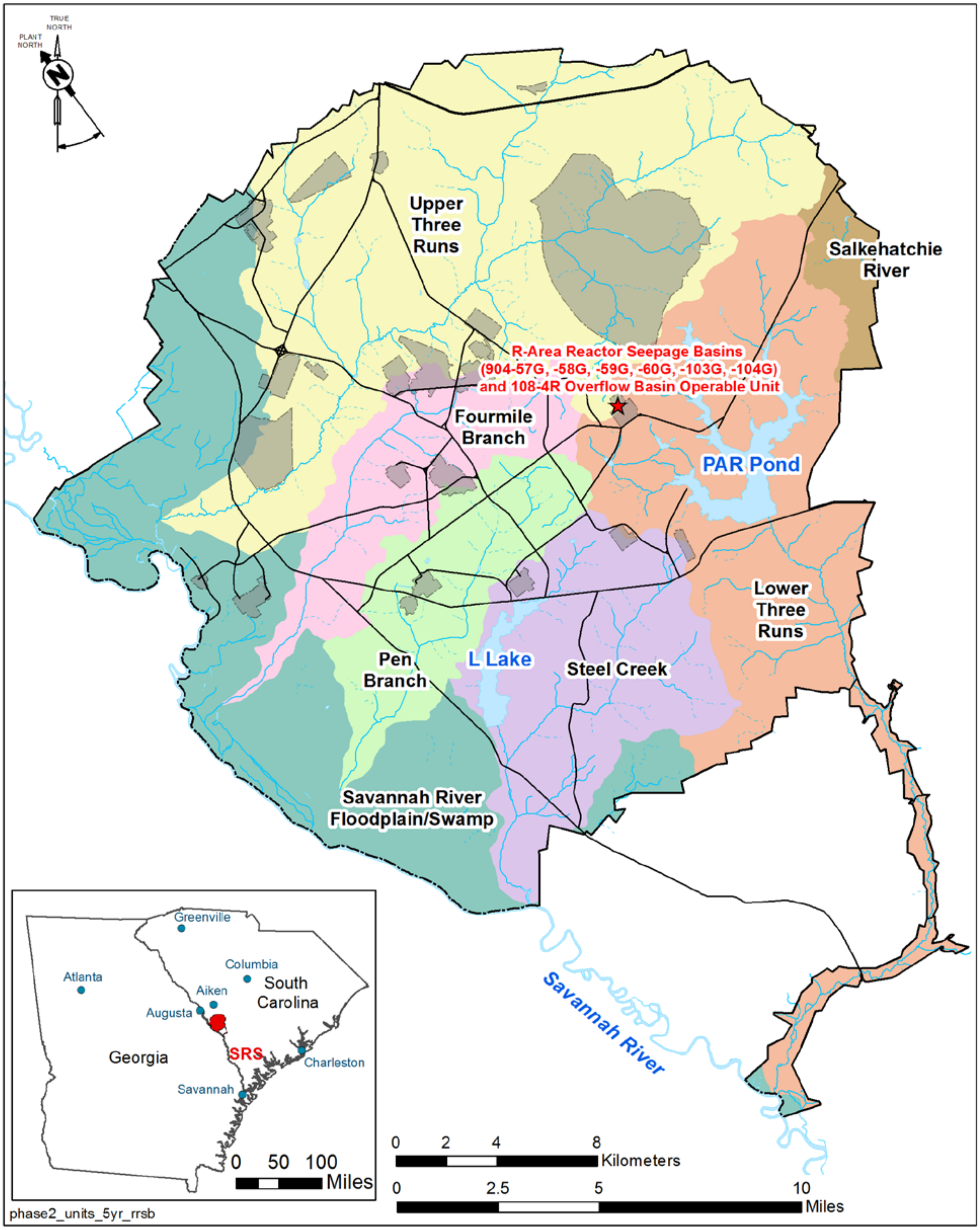


Figure I-1. R-Area Reactor Seepage Basins Operable Unit

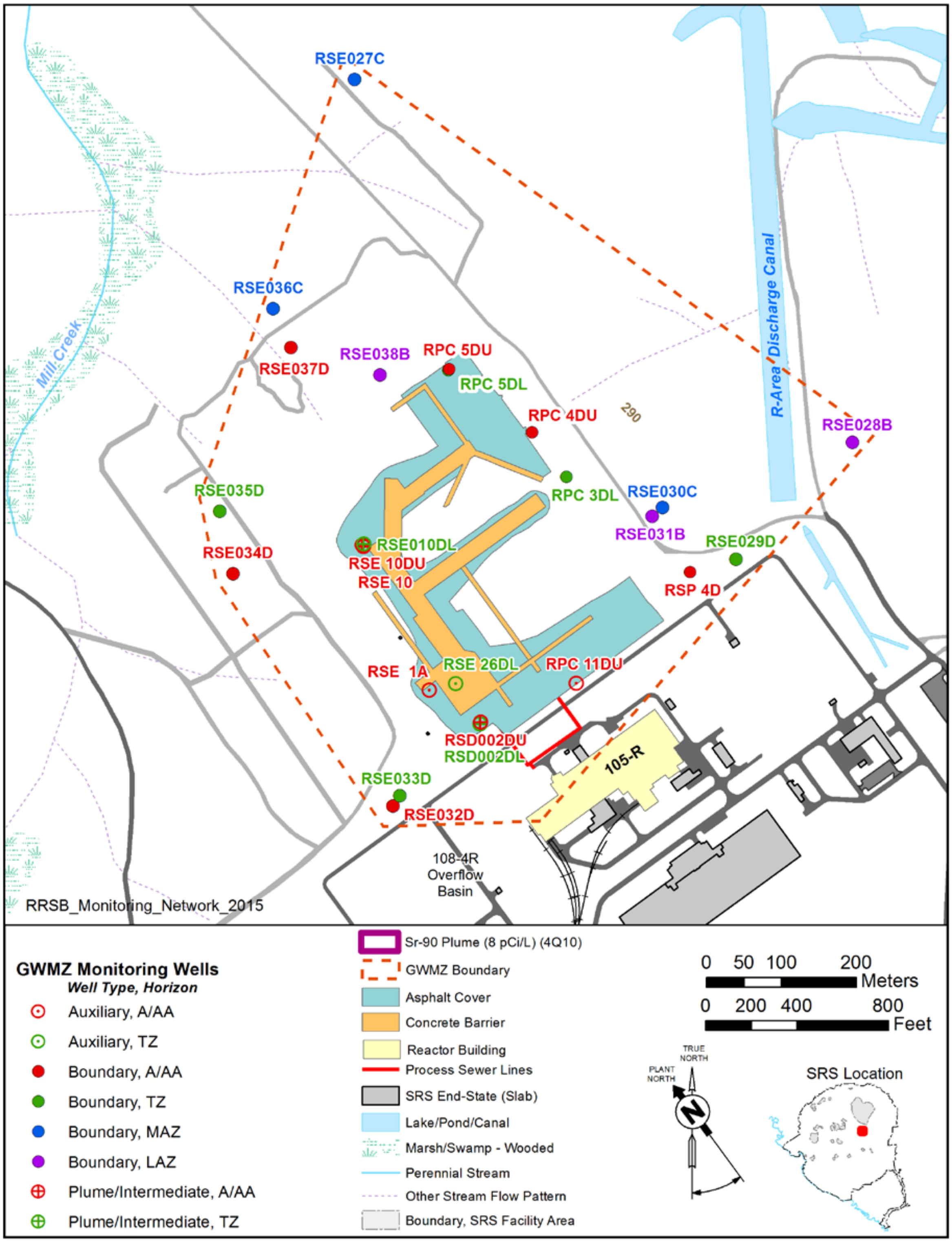


**Figure I-2. Current Layout of the RRSB OU with Monitoring Well Network**

**Figure I-3. Photograph of the R-Reactor Seepage Basins prior to Record of Decision approved remedial action (exact date unknown)**


**Figure I-4. Current Aerial Photo of the R-Reactor Seepage Basins OU (2010)**

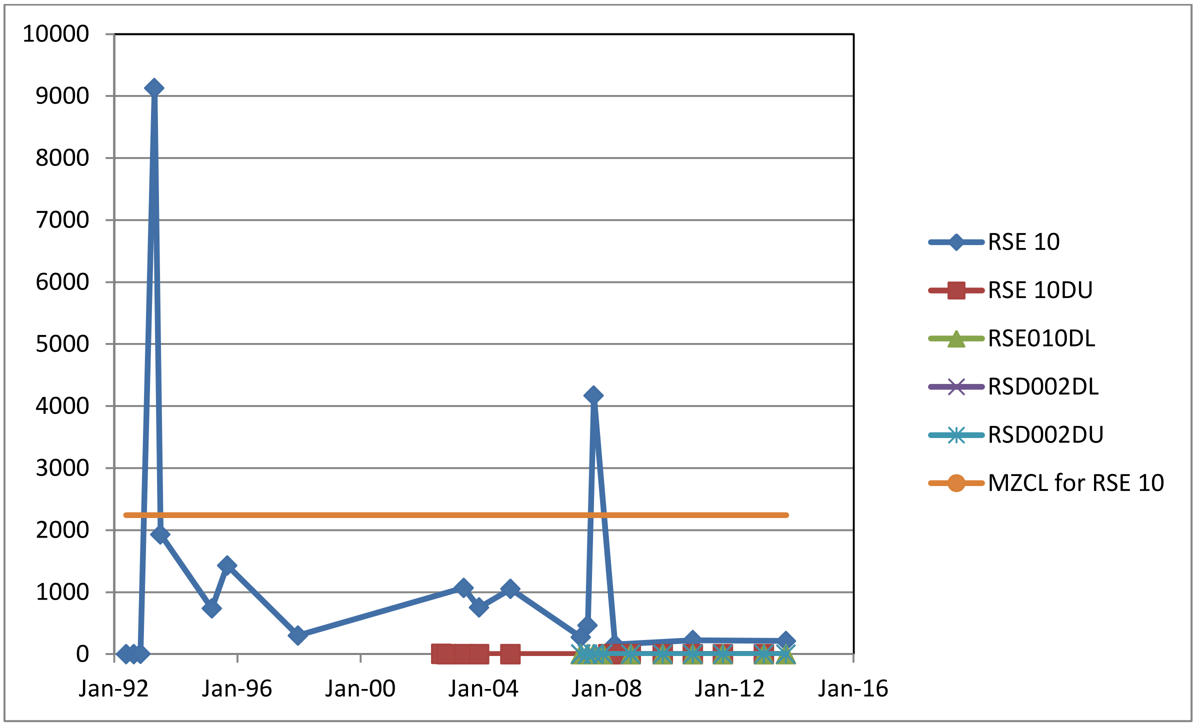


**Figure I-5. Strontium-90 Time Trend Data for RRSB Plume/Intermediate Wells**

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**Table I-1. Chronology of OU Events**

| Event | Date |
|---|---|
| RFI/RI Field Start / Complete | 1995 / 2000 |
| Removal Action and Asphalt Cover Completed | 1996 |
| CMS/FS Rev 1 Submittal | January 30, 2003 |
| Record of Decision (ROD) Issuance | March 10, 2004 |
| Remedial Action Start / Complete | March 4, 2005 / January 30, 2008 |
| Previous Five-Year Review | February 4, 2009 / February 4, 2014 |

**Table I-2. Final COCs and RGs for 1E-06 Risk to Industrial Worker at RRSB OU**

| Medium | Final COC | CM RG | HH RG | ECO RG (Earthworm) |
|---|---|---|---|---|
| Surface Soil | Cesium-137 | | 0.105 ρCi/g | |
| Subsurface Soil | Americium-241 | | 7.75 ρCi/g | 332 ρCi/g |
| | Cesium -137 | | 0.105 ρCi/g | 2220 ρCi/g |
| | Cobalt-60 | | 0.0225 ρCi/g | |
| | Plutonium-238 | | 10.4 ρCi/g | |
| | Plutonium -239/240 | | 9.69 ρCi/g | |
| | Strontium-90 | | 56.5 ρCi/g | 2420 ρCi/g |
| Total Soil Profile | Americium-241 | 0.0532 ρCi/g | | |
| | Carbon-14 | 4.08 ρCi/g | | |
| | Plutonium -239/240 | 0.0138 ρCi/g | | |
| | Strontium-90 | 0.0532 ρCi/g | | |
| Groundwater | Americium-241 | | 0.488 ρCi/L | |
| | Strontium-90 | | 2.86 ρCi/L | |

Notes: CM – Contaminant Migration
HH – Human Health
ECO - Ecological

**Table I-3. Actual versus Estimated O&M Costs**

| | FY2012 | FY2013 | FY2014 | FY2015 | 4-Year Total |
|---|---|---|---|---|---|
| Total Actual O&M Costs ($) | 90,100 | 87,322 | 129,215 | 309,519 | 616,165 |
| Total ROD Estimated Direct O&M Costs ($) | 333,326[1] | 320,000 | 320,000 | 320,000 | 1,293,326 |

[1]FY2012 estimated costs include costs associated with the fourth five-year remedy review.

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## Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit

**I. SITE INFORMATION**

| | | | |
|---|---|---|---|
| **Site Name:** | **R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit** | **Date of Inspection:** | **07/29/2015** |
| **Location and Region** | **SRS, USEPA Region 4** | **EPA ID:** | **CERCLIS #25** |
| **Agency, Office, or Company leading the Five-Year Review** | **USDOE** | **Weather/ Temperature** | **75°F and clear** |

**Remedy Includes:** *(Click all that apply)*

- ☒ Landfill Cover/Containment
- ☒ Access Controls
- ☒ Institutional Controls
- ☐ Groundwater Pump and Treatment
- ☐ Surface Water Pump and Treatment
- ☒ Monitored Natural Attenuation
- ☐ Groundwater Containment
- ☐ Vertical Barriers
- ☒ Other Mixing Zone (groundwater); Excavation/Consolidation of process and sanitary sewer lines

**Attachments:** ☐ Inspection team roster attached ☐ Inspection team roster attached

**II. INTERVIEWS** *(Click all that apply)*

1. **O&M Site Manager:** George Joyner (Name) Post Closure Manager (Title) 7/15/2015 (Date)

   **Interviewed:** ☐ At Site ☒ At Office ☐ By Phone Phone No.: 803-952-3324

   **Problems/Suggestions:** ☐ Report Attached

2. **O&M Staff:** Richard Feagin (Name) ACP Post Closure Waste Site Inspector/Maintenance Coord. (Title) 07/15/2015 (Date)

   **Interviewed:** ☒ At Site ☐ At Office ☐ By Phone Phone No.: 803-952-4416

   **Problems/Suggestions:** ☐ Report Attached

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

**II. INTERVIEWS *(Click all that apply)(Continued)***

3. **Local Regulatory Authorities and Response Agencies** (i.e., State and tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds or other city and county offices, etc.). Fill in all that apply.

**Agency:** ______________________

**Contact:** ____________ ____________ ____________ ____________
(Name) (Title) (Date) (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ____________ ____________ ____________ ____________
(Name) (Title) (Date) (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

**Agency:** ______________________

**Contact:** ____________ ____________ ____________ ____________
(Name) (Title) (Date) (Phone No.)

**Problems/Suggestions:** ☐ Report Attached ______________________

______________________

4. **Other Interviews** *(Optional):* ☐ Report Attached

______________________

**III. ONSITE DOCUMENTS & RECORDS VERIFIED** *(Click all that apply)*

1. **O&M Documents:**

| | | | |
|---|---|---|---|
| ☐ O&M Manual | ☐ Readily Available | ☐ Up to Date | ☐ N/A |
| ☒ As-Built Drawings | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| ☐ Maintenance Logs | ☐ Readily Available | ☐ Up to Date | ☐ N/A |

Remarks: Annual site inspections are performed per SRS procedure ER-SOP-019, *Waste Unit Inspection and Maintenance*, and ER-IDS-019-048, *Field Inspection Checklist for the RRSB.*

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

| III. ONSITE DOCUMENTS & RECORDS VERIFIED *(Continued)* | | | |
|---|---|---|---|
| **2. Health and Safety Plans (HASPs):** | | | |
| ☐ Site-Specific Health and Safety Plans | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Contingency Plan/Emergency Response Plan | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: Routine O&M activities do not require a SSHASP under 29 CFR 1910.1201.HAZWOPER | | | |
| **3. O&M and OSHA Training Records:** | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| Remarks: Training Records are complete and up to date per ACP training matrix. | | | |
| **4. Permits and Service Agreements:** | | | |
| ☐ Air Discharge Permit | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Effluent Discharge | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Waste Disposal; POTW | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Other Permits | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: | | | |
| **5. Gas Generation Records:** | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: | | | |
| **6. Settlement Monument Records:** | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: | | | |
| **7. Groundwater Monitoring Records:** | ☒ Readily Available | ☒ Up to Date | ☐ N/A |
| Remarks: | | | |
| **8. Leachate Extraction Records:** | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: | | | |
| **9. Discharge Compliance Records:** | | | |
| ☐ Air | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| ☐ Water (Effluent) | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: | | | |
| **10. Daily Access/Security Logs:** | ☐ Readily Available | ☐ Up to Date | ☒ N/A |
| Remarks: | | | |

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

**IV. O&M COSTS**

**1. O&M Organization:**

☐ State In-House ☐ Contractor for State
☐ PRP In-House ☐ Contractor for PRP
☒ Other: SRS

**2. O&M Cost Records:**

☐ Readily Available ☐ Up to Date ☐ Funding mechanism/agreement in place
☒ Other: Project cost data is summarized in Section IV of this OU-specific review.

**Total annual cost by year for review period, if available**

From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached
From:________ (Date) To:________ (Date) ________ (Total Cost) ☐ Breakdown attached

**3. Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: N/A

**V. ACCESS AND INSTITUTIONAL CONTROLS** ☒ Applicable ☐ N/A

**A. Fencing**

**1. Fencing Damage:** ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks:

**B. Signs**

**1. Signs and Other Security Measures:** ☐ Location shown on site map ☐ N/A

Remarks: Signs at this site are in good condition.

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

**V. ACCESS AND INSTITUTIONAL CONTROLS *(Continued)***

**C. Institutional Controls**

**1. Implementation and Enforcement**

Site conditions imply ICs are not properly implemented: ☐ Yes ☒ No ☐ N/A
Site conditions imply ICs are not being fully enforced: ☐ Yes ☒ No ☐ N/A

Type of monitoring (e.g., self-reporting, drive-by, etc.) Field Walk Down
Frequency: Annually
Responsible Party/Agent: USDOE Savannah River Field Office
Contact: Phil Prater (Name) RCRA/Remedial Program Manager (Title) 10/26/15 (Date) 803-952-9333 (Phone No.)

Reporting is up-to-date: ☒ Yes ☐ No ☐ N/A
Reports are verified by the lead agency: ☒ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met: ☒ Yes ☐ No ☐ N/A
Violations have been reported: ☐ Yes ☐ No ☒ N/A
Problems/Suggestions: ☐ Report Attached

**2. Adequacy:** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
Remarks: The ICs are adequately maintaining the RRSB protective systems. When maintenance activities are identified during inspections (e.g., repairing holes and concrete spalling, vegetation removal from the cover system), repairs are scheduled and performed.

**D. General**

**1. Vandalism/Trespassing:** ☐ Location shown on site map ☒ No vandalism is evident
Remarks:

**2. Land use changes onsite:** ☒ N/A
Remarks:

**3. Land use changes offsite:** ☒ N/A
Remarks:

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

| VI. GENERAL SITE CONDITIONS |
|---|
| **A. Roads** ☒ Applicable ☐ N/A |
| **1. Roads damaged:** ☒ Location shown on site map ☒ Roads adequate ☐ N/A<br>Remarks:______ |
| **B. Other Site Conditions** |
| Remarks: Vegetation mowed routinely______<br>.______ |
| **VII. LANDFILL COVER/CONTAINMENT** ☒ Applicable ☐ N/A |
| **A. Landfill Surface** |
| **1. Settlement** (Low spots)**:** ☐ Location shown on site map ☒ Settlement not evident<br>Areal extent______ Depth______<br>Remarks:______ |
| **2. Cracks:** ☐ Location shown on site map ☒ Cracking not evident<br>Lengths______ Widths______ Depths______<br>Remarks:______ |
| **3. Erosion:** ☐ Location shown on site map ☒ Erosion not evident<br>Areal extent______ Depth______<br>Remarks:______ |
| **4. Holes:** ☐ Location shown on site map ☒ Holes not evident<br>Areal extent______ Depth______<br>Remarks:______ |
| **5. Vegetative Cover:** ☐ Grass ☐ Cover properly established ☐ No signs of stress<br>Areal extent______ Depth______<br>Remarks: NA.______ |

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

**VII. LANDFILL COVER/CONTAINMENTS *(Continued)***

**6. Alternative Cover (armored rock, concrete, etc.):** ☐ N/A

Remarks: The cover system includes a concrete intruder barrier, an asphalt bioturbation barrier, and the original asphalt cover installed in 1996.

**7. Bulges:** ☐ Location shown on site map ☒ Bulges not evident

Areal extent__________ Depth__________

Remarks:__________

**8. Wet Areas / Water Damage:** ☒ Wet areas/water damage not evident

☐ Wet areas ☐ Location shown on site map Areal extent__________

☐ Ponding ☐ Location shown on site map Areal extent__________

☐ Seeps ☐ Location shown on site map Areal extent__________

☐ Soft subgrade ☐ Location shown on site map Areal extent__________

Remarks:__________

**9. Slope Instability:** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability

Areal extent__________

Remarks:__________

**B. Benches** ☐ Applicable ☒ N/A

(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel)

**C. Letdown Channels** ☐ Applicable ☒ N/A

(Channel lined with erosion control mates, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies)

**D. Cover Penetrations** ☒ Applicable ☐ N/A

**1. Gas Vents:** ☐ Active ☐ Passive

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A

Remarks:__________

**2. Gas Monitoring Probes:**

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition

☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A

Remarks:__________

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

| **VII. LANDFILL COVER/CONTAINMENTS *(Continued)*** |
|---|
| **3. Monitoring Wells:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A<br>Remarks:___ |
| **4. Leachate Extraction Wells:**<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good Condition<br>☐ Evidence of leakage at penetration ☐ Needs maintenance ☒ N/A<br>Remarks:___ |
| **5. Settlement Monuments:** ☐ Located ☐ Routinely Surveyed ☒ N/A<br>Remarks:___ |
| **E. Gas Collection and Treatment** ☐ Applicable ☒ N/A |
| **F. Cover Drainage Layer** ☐ Applicable ☒ N/A |
| **G. Detention/Sedimentation Ponds** ☐ Applicable ☒ N/A |
| **H. Retaining Walls** ☐ Applicable ☒ N/A |
| **I. Perimeter Ditches/Offsite Discharge** ☒ Applicable ☐ N/A |
| **1. Siltation:** ☐ Location shown on site map ☒ Siltation not evident<br>Areal extent___ Depth___<br>Remarks:___ |
| **2. Vegetative Growth:** ☐ Location shown on site map ☐ N/A<br>☒ Vegetation does not impede flow<br>Areal extent___ Type___<br>Remarks:___ |
| **3. Erosion:** ☐ Location shown on site map ☒ Erosion not evident<br>Areal extent___ Depth___<br>Remarks:___ |
| **4. Discharge Structure:** ☐ Location shown on site map ☒ N/A<br>Remarks:___ |

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

| |
|---|
| **VIII. VERTICAL BARRIER WALLS** ☐ **Applicable** ☒ **N/A** |
| **IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A |
| **A. Groundwater Extraction Wells, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| **C. Treatment System** ☐ Applicable ☒ N/A |
| **D. Monitoring Data** ☒ Applicable ☐ N/A |
| **1. Monitoring Data:**<br>☒ Is routinely submitted on time ☒ Is of acceptable quality |
| **2. Monitoring Data:**<br>☐ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining |
| **E. Monitored Natural Attenuation** ☒Applicable ☐ N/A |
| **1. Monitoring Wells** *(natural attenuation remedy)***:**<br>☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition<br>☒ All required wells located ☐ Needs maintenance ☐ N/A<br>Remarks:________________________________________ |
| **X. OTHER REMEDIES** |
| If there are remedies applied at the site, which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction. |
| **A. Soil Vapor Extraction System** ☐ Applicable ☒ N/A |

**Attachment I-1. Five-Year Review Site Inspection Checklist – R-Area Reactor Seepage Basins (904-57G, -58G, -59G, -60G, -103G, -104G) and 108-4R Overflow Basin Operable Unit *(continued)***

**XI. OVERALL OBSERVATIONS**

**A. Implementation of the Remedy**

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emissions, etc.).

The selected remedy for the R-Area Reactor Seepage Basin is the installation of a reinforced concrete intruder barrier system over PTSM with granitic monuments, installation of an asphalt bioturbation barrier over contaminated vegetation areas, excavation and consolidation on-unit of PTSM outside boundary fence, monitored natural attenuation (MNA) by radioactive decay with mixing zone for groundwater, and institutional controls. Selected remedies for the RRSB OU are functioning as intended. There are no issues requiring corrective actions.

**B. Adequacy of O&M**

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The O&M procedures consisting of annual site inspections and site maintenance (repair of erosion damage, cover system, fencing and warning signs) and site controls (SRS Site Use and Site Clearance Programs, which restrict invasive and permanent installation activities at the waste unit) have been implemented. The O&M procedures are adequately maintaining the physical integrity of the cover system, the condition of the fencing and warning signs is good. When maintenance activities are identified during inspections (e.g., repairing holes, concrete spalling, vegetation removal from the cover system), repairs are scheduled and performed. There are no issues requiring corrective actions.

**C. Early Indicators of Potential Remedy Failure**

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

N/A

**D. Opportunities for Optimization**

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

N/A

***End of Checklist***