Savannah River NUCLEAR SOLUTIONS℠

Environmental Compliance and Area Completion Projects Regulatory Document Handbook

SRNS-RP-2022-00330

Revision 0

June 2023, updated December 2025 (corrected)

DISCLAIMER

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy.

This work was prepared under an agreement with and funded by the U.S. Government. Neither the U.S. Government or its employees, nor any of its contractors, subcontractors or their employees, makes any express or implied: 1. warranty or assumes any legal liability for the accuracy, completeness, or for the use or results of such use of any information, product, or process disclosed; or 2. representation that such use or results of such use would not infringe privately owned rights; or 3. endorsement or recommendation of any specifically identified commercial product, process, or service. Any views and opinions of authors expressed in this work do not necessarily state or reflect those of the United States Government, or its contractors, or subcontractors.

Printed in the United States of America

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

EXECUTIVE SUMMARY

This Environmental Compliance and Area Completion Project (EC&ACP) Regulatory Document Handbook serves as a comprehensive set of Core Team guidance materials for the evaluation of Savannah River Site (SRS) operable units (OUs) and decommissioning facilities. The Core Team is comprised of representatives from the United States Department of Energy (USDOE), U.S. Environmental Protection Agency (USEPA), and South Carolina Department of Health and Environmental Control (SCDHEC) with decision-making authority for the SRS environmental cleanup program. The document formats and technical protocols contained in this handbook are used by USDOE to evaluate OUs and facilities for decommissioning to prepare project scoping materials and regulatory documentation. They are employed by the USEPA and SCDHEC to scope and review Remedial Investigation/Feasibility Study (RI/FS) projects and support remedial decisions.

These Core Team consensus formats and technical protocols are intended for use only in the SRS Federal Facility Agreement (FFA) cleanup program.

Environmental cleanup activities have been ongoing at SRS under an FFA since 1993. As the program matured, the FFA project managers recognized that meeting FFA milestones was overshadowed by ineffective decision making that resulted in project rework, major regulatory document revisions, and project delays. In June 1999, the USEPA and SCDHEC agreed to a "time-out" on a number of RI/FS projects to support an initiative to evaluate the approach to RI/FS decision making. Through this initiative, the following issues were identified:

- Unclear problem definition (e.g., inadequate RI/Baseline Risk Assessment [RI/BRA] documentation leads to difficulties transitioning from the RI/BRA to the Corrective Measures Study/FS [CMS/FS]);
- Ineffective CMS/FS scoping; and
- Inadequate CMS/FS documentation.

A multi-disciplinary team comprised of representatives from the USEPA, SCDHEC, and USDOE (i.e., Core Team) and the SRS contractor was established to reach agreement on solutions to these

problems that would be effective, acceptable, and implementable. The team employed the DOE/EPA Principles of Environmental Restoration throughout the process. The result of this collaboration was a new approach to RI/FS projects that focused on Core Team communication (i.e., project scoping) followed by agreement on the project direction prior to preparing the regulatory documentation.

Principles of Environmental Restoration

- Building an effective Core Team is essential.
- Clear, concise, and accurate problem identification and definition are critical.
- Early identification of likely response actions is possible, prudent, and necessary.
- Uncertainties are inherent and will always need to be managed.

A key factor to determine the technical direction of RI/FS projects and acceptance of the technical results is Core Team agreement on the technical processes employed. The USEPA publishes guidance for data processing, human health and ecological risk assessments, fate and transport modeling, groundwater modeling, etc., in addition to guidance for the content and format of regulatory documentation. However, the USDOE, USEPA, and SCDHEC recognized that subject matter experts (SMEs) may differ on how published guidance should be applied to individual OUs and/or facilities for decommissioning.

During the FFA program "time-out," the USDOE, USEPA, and SCDHEC agreed to promote consistency in application of published guidance in the preparation and review of RI/FS documents. The three agencies formed technical Design Teams represented by SMEs from their respective agencies. Each Design Team developed technical protocols to support consistent execution of the technical scope in SRS RI/FS projects. **These technical protocols are not intended to replace or contradict federal or state regulations or published guidance materials.** Rather, the technical protocols provide program-level agreement on standard processes so that baseline steps do not require renegotiation for each RI/FS project unless there is an identified need to deviate from the agreed-upon protocols (i.e., site-specific conditions, regulatory driver, etc.). The Design Teams also developed regulatory document formats to promote

consistency in the preparation and review of RI/FS and remedial decision documents. The development and use of approved technical protocols and document formats to standardize many of the tasks involved in waste site investigation, assessment and cleanup, and facility decommissioning is recognized by all three agencies to be a vital and powerful tool for building Core Team consensus at all project phases and streamlining the efficient implementation of the FFA.

This EC&ACP Regulatory Document Handbook assembles the standard document formats and technical protocols agreed to by the Core Team. A document number, revision number, and revision date are assigned to the EC&ACP Regulatory Document Handbook. Each document format and technical protocol has an individual revision number and revision date as reflected in the Table of Contents. Unless a major change is needed that impacts the overall handbook process, the handbook revision number does not change when an update to an individual document format and/or technical protocol is made. Rather, the change is recognized by updating the Table of Contents, and the handbook cover page will reflect a revised date.

The EC&ACP Regulatory Document Handbook (SRNS-RP-2022-00330, Revision 0, June 2023) supersedes the previously published EC&ACP Regulatory Document Handbook (ERD-AG-003, Revision 17, June 2012). A record of modifications to the handbook is available in Appendix A. A table describing the five phases of project scoping is provided in Appendix B.

This page is intentionally left blank.

TABLE OF CONTENTS

Part I RCRA/CERCLA Document Formats

Format/Protocol No.	Document Format Name	Revision No.	Revision Date
F-1	Remedial Site Evaluation Report Format	0	6/2023
F-2	RCRA Facility Investigation/Remedial Investigation Work Plan Format	0	6/2023
F-3	RCRA Facility Investigation/Remedial Investigation/Baseline Risk Assessment Format	0	6/2023
F-4	Corrective Measures Study/Feasibility Study Format	0	6/2023
F-5	Combined RCRA Facility Investigation/ Remedial Investigation/Baseline Risk Assessment/Corrective Measures Study/ Feasibility Study Format	0	6/2023
F-6	Statement of Basis/Proposed Plan Format	1	12/2025
F-7	Statement of Basis/Proposed Plan Fact Sheet Format	0	6/2023
F-8	Record of Decision Format	0	6/2023
F-9	Land Use Control Implementation Plan Format	0	6/2023
F-10	Corrective Measures Implementation Plan/ Remedial Action Implementation Plan Format	0	6/2023
F-11	Post-Construction Report Format	0	6/2023
F-12	Corrective Measures Implementation Report/ Remedial Action Completion Report Format	0	6/2023
F-13	Post-Construction Report/Corrective Measures Implementation Report/ Remedial Action Completion Report Format	0	6/2023
F-14	Sampling and Analysis Plan Format	0	6/2023
F-15	Data Usability Report Format	0	6/2023
F-16	Performance Evaluation Report Format	0	6/2023
F-17	Effectiveness Monitoring Report Format	0	6/2023
F-18	Removal Site Evaluation Report Format	0	6/2023
F-19	Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis Format	0	6/2023
F-20	Removal Action Design Plan Format	0	6/2023
F-21	Removal Action Report Format	0	6/2023
F-22	Comment Response Format	0	6/2023
F-23	Facility Decommissioning Evaluation Format	0	6/2023
F-24	Decommissioning Project Final Report Format	0	6/2023

TABLE OF CONTENTS *(continued)*

Part II Technical Protocols

Format/Protocol No.	Technical Protocol Name	Revision No.	Revision Date
Module 1 – Data Grouping (DG)			
DG-1	Development of Exposure Groups	0	6/2023
DG-2	Exposure Pathways/Conceptual Site Model	0	6/2023
DG-3	Addressing the Combined Surficial Risks from Adjacent Units	0	6/2023
Module 2 – Data Processing (DP)			
DP-1	Unit Source Data Processing	0	6/2023
DP-2	Unit Background Data Processing	0	6/2023
DP-3	Surrogates for Non-Detects	0	6/2023
Module 3 – Unit-Specific Constituents (USC)			
USC-1	Unit-Specific Constituents	0	6/2023
Module 4 – ARARs			
ARAR-1	ARAR Constituents of Concern	0	6/2023
ARAR-2	ARAR Preliminary Remedial Goals	0	6/2023
Module 5 – Contaminant Migration (CM)			
CM-1	CM Model (VZCOMML)	0	6/2023
CM-2	CM Constituents of Concern	0	6/2023
CM-3	CM Preliminary Remedial Goals	0	6/2023
Module 6 – Human Health Risk (HH)			
HH-1	HH Sources of Screening Values	0	6/2023
HH-2	HH Receptors and Scenarios	0	6/2023
HH-3	HH RME Exposure Parameters	0	6/2023
HH-4	HH Constituents of Potential Concern	0	6/2023
HH-5	HH Constituents of Concern	0	6/2023
HH-6	HH Preliminary Remedial Goals	0	6/2023
HH-7	HH Evaluation of Principal Threat Source Material (PTSM) at SRS Waste Units	0	6/2023
Module 7 – Ecological Risk (ECO)			
ECO-1	ECO Sources of Screening Values	0	6/2023
ECO-2	ECO Receptors and Measurement/Assessment Endpoints	0	6/2023
ECO-3	ECO Constituents of Potential Ecological Concern	0	6/2023
ECO-4	ECO Constituents of Potential Concern / Constituents of Concern	0	6/2023
ECO-5	ECO Site-Specific Data/Studies	0	6/2023
ECO-6	ECO Preliminary Remedial Goals	0	6/2023

TABLE OF CONTENTS *(continued/end)*

Part II Technical Protocols *(continued/end)*

Format/Protocol No.	Document Format Name	Revision No.	Revision Date
Module 8 – Constituents of Concern (COC)			
COC-1	Constituents of Concern (COC) Refinement Process	0	6/2023
Module 9 – Groundwater Modeling (GW)			
GW-1	Groundwater Modeling in the RCRA/CERCLA Process	0	6/2023
GW-2	Developing the Hydrogeological Conceptual Model	0	6/2023
GW-3	Groundwater Model Selection, Design, and Application	0	6/2023
GW-4	Sensitivity and Uncertainty Analyses for RCRA/CERCLA Groundwater Modeling	0	6/2023
GW-5	Process for Use of Monitored Natural Attenuation and Groundwater Mixing Zone Application	0	6/2023
Module 10 – Decommissioning (D)			
D-1	Core Team Protocol For Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports	1	6/2023
D-2	Core Team Protocol for Reuse of Federal Facility Agreement Decommissioned Excess Facilities	0	12/2025

LIST OF APPENDICES

Appendix A Record of Modifications to the EC&ACP Regulatory Document Handbook

Appendix B Five Phases of Project Scoping

This page is intentionally left blank.

LIST OF KEY ACRONYMS AND ABBREVIATIONS[1]

ARAR	applicable or relevant and appropriate requirement
ARF	Administrative Record File
ASTM	American Society for Testing and Materials
AWQC	ambient water quality criteria
BPRG	building preliminary remediation goal
BRA	Baseline Risk Assessment
CA	Cost Analysis
CAB	Citizen Advisory Board
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CM	contaminant migration
CMIP	Corrective Measures Implementation Plan
CMIR	Corrective Measures Implementation Report
CMS	Corrective Measures Study
COC	constituent of concern
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	conceptual site model
D&D	deactivation and decommissioning
DQO	data quality objective
DPFR	Decommissioning Project Final Report
DUR	Data Usability Report
EC&ACP	Environmental Compliance and Area Completion Projects
ECO	ecological
EE	Engineering Evaluation
EG	exposure group
EMR	Effectiveness Monitoring Report
ERA	ecological risk assessment
ESD	Explanation of Significant Differences
EPC	exposure point concentration
ESL	ecological screening level
ESV	ecological screening value
F&T	flow and transport
FDE	Facility Decommissioning Evaluation
FFA	Federal Facility Agreement
FS	Feasibility Study
HASP	Health and Safety Plan
HCM	hydrogeologic conceptual model

[1] Represents commonly used acronyms in formats/protocols but is not intended to represent a comprehensive list of all acronyms.

LIST OF KEY ACRONYMS AND ABBREVIATIONS (continued)

HH	human health
HI	hazard index
HHRA	human health risk assessment
HQ	hazard quotient
IDW	investigation derived waste
IOU	Integrator Operable Unit
IROD	Interim Record of Decision
LANL	Los Alamos National Laboratory
LOAEL	lowest observed adverse effects level
LUC	land use control
LUCAP	Land Use Control Assurance Plan
LUCIP	Land Use Control Implementation Plan
MCL	maximum contaminant level
MDA	method detection activity
MDL	method detection limit
MNA	monitored natural attenuation
MZCL	mixing zone concentration limits
NAPL	non-aqueous phase liquid
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NOAEL	no observed adverse effects level
NTC	non-time critical
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCB	polychlorinated biphenyl
PCR	Post Construction Report
PER	Performance Evaluation Report
PP	Proposed Plan
PQO	project quality objective
PRG	preliminary remediation goal, preliminary remedial goal
PTSM	principal threat source material
QA	quality assurance
QAPP	Quality Assurance Program Plan
QC	quality control
RA	remedial action
RACR	Removal Action Completion Report

LIST OF KEY ACRONYMS AND ABBREVIATIONS (continued/end)

RAGS	Risk Assessment Guidance for Superfund
RAIP	Remedial Action Implementation Plan
RAO	remedial action objective
RACM	removal action conceptual model
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	Remedial Facility Investigation
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
RSER	Removal Site Evaluation Report
RSL	regional screening level
RSV	refinement screening value
S&M	surveillance and maintenance
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments Reauthorization Act
SB	Statement of Basis
SCDHEC	South Carolina Department of Health and Environmental Control
SCHWMR	South Carolina Hazardous Waste Management Regulations
SEA	site evaluation area
SEMS	Superfund Enterprise Management Systems
SER	Site Evaluation Report
SME	subject matter expert
SPRG	surface preliminary remediation goal
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SSL	soil screening levels
TAL	Target Analyte List
TBC	to-be-considered
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TES	threatened, endangered and sensitive (species)
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USC	Unit-Specific Constituent
VOC	Volatile Organic Compound

This page is intentionally left blank.

Part I

RCRA/CERCLA Document Formats

This page is intentionally left blank.

REMEDIAL SITE EVALUATION REPORT FORMAT

Remedial Site Evaluation Reports (SERs) are prepared in accordance with Section 300.410 and 300.420 of the National Contingency Plan (NCP). They are mandated by the Savannah River Site (SRS) Federal Facility Agreement (FFA), Section X, Site Evaluations. SERs are developed for Site Evaluation Areas (SEAs) listed on FFA Appendix G.1, Areas To Be Investigated.

1.0 INTRODUCTION

The purpose of this section is to provide the primary reason to evaluate the SEA for potential remedial investigation and action. A brief history of the SEA and suspected contaminants is discussed in this section. The SER provides sufficient information concerning conditions at the SEA to assess the threat, if any, posed to human health and the environment and to determine the need for additional action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or other appropriate actions. The scope of the investigation includes a review of files and historical data, site visits, interviews, media sampling and analysis (if applicable), and a Radiological Control Survey.

2.0 AREA DESCRIPTION, OPERATIONAL HISTORY, AND WASTE CHARACTERISTICS

2.1 Location

The purpose of this section is to provide an introduction to the SRS and identify the location of the SEA within the SRS. Figures that are referenced in this section may include a figure showing the geographic proximity of the SRS, a general site map showing the location of the SEA within the SRS, and a specific (detailed) SEA map, if appropriate.

2.2 Area Description

The purpose of this section is to physically describe the SEA including its location in a SRS watershed, surface and drainage features, and the environmental setting. The environmental setting includes a description of vegetation communities, the location of nearby Threatened and Endangered Species and/or sensitive habitats, topography, location within close proximity to

wetlands or surface water, depth to groundwater, average rainfall, and other applicable environmental characteristics. The location and description of the nearest RCRA/CERCLA unit and closest SEA, particularly if up- or side-gradient to the SEA, is included. A brief description of the waste/contaminants for nearby Resource Conservation and Recovery Act (RCRA)/CERCLA units and/or SEAs including the dates of approved reports, previous decisions and decision dates by the United States Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control, recommended actions, previous removal actions, and/or deactivation and decommissioning activities are included in this section.

2.3 Operational History and Waste Characteristics

This section provides a description of the history of the SEA including past operations and waste practices, time periods that the SEA opened and closed, a description of material that was or may have been dumped/stored/spilled, and any other applicable information on hazardous materials at the SEA. If available, spill reports are included in an appendix. Historical and/or current photographs may be referenced in this section.

3.0 SAMPLING/MONITORING DATA HISTORY

3.1 Sampling Data

This section describes any sampling activities conducted at the SEA (i.e., radiological control survey, soil sampling, asbestos inspections, groundwater sampling if applicable, and other characterization efforts). If field sampling is conducted, a thorough discussion of sampling activities including sampling locations (e.g., figures and maps), sample depths, number of samples, laboratory analysis, and the sampling results is provided in the text and supported by the appendices.

Even when field sampling is not required, a Radiological Control Survey is performed unless the SEA is inside a building or is located within a radiological area or has routine radiological surveys performed as part of a facility. A Radiological Control Survey of the SEA consists of measuring background radiation levels, probing the surface for possible contamination, and collecting random soil samples (0-6 inches below the ground surface) for analysis in a radiological counting facility.

If contamination is found, additional radiological screening for alpha and non-volatile beta contamination for a limited number of samples may occur. This section will discuss the results of the radiological survey and reference the survey results, radiological screening, and figure(s) showing the bounds of the radiological survey in an appendix.

If soil or other environmental media samples are collected, this section briefly describes the sampling strategy (e.g., biased sampling for contaminant source areas, etc.) and analysis (e.g., target analyte list, target compound list, radionuclides, etc.). Soil data is compared to the most recent USEPA preliminary remediation goals (PRGs) for radiological constituents (if radiological samples were collected) and regional screening levels (RSLs) for nonradiological constituents for unrestricted land use. Naturally occurring inorganics and radionuclide constituents are compared to two times the average background concentration from the approved SRS soil background dataset. A table showing the results of the screening steps is included in the SER.

The quality control and quality assurance (QA/QC) and any discrepancies in the laboratory analyses are discussed. Sample location maps and data tables with pertinent QA/QC information are included.

3.2 Risk Assessment

A risk assessment and contaminant migration analysis (if appropriate) may be performed to support the conclusion that the SEA poses no threat to human health and the environment with the recommendation that the SEA be placed on Appendix G.2, Areas Determined to Require No Further Response Action. If it is apparent that the SEA will be placed on FFA Appendix C, RCRA/CERCLA List for further evaluation under the RCRA Feasibility Investigation (RFI)/Remedial Investigation (RI) Program based on the data screening performed in Section 3.1, then a risk assessment and contaminant migration analysis may not be needed.

This section presents the conclusions of the risk assessment that is included as an appendix to this document. The data for the SEA is processed in accordance with the protocols presented in Module 5, Contaminant Migration Analysis; Module 6, Human Health Risk; and Module 7, Ecological Risk to the extent applicable.

3.3 Monitoring History

This section provides a discussion of any monitoring performed at the SEA. If no monitoring has been performed, a statement will be included in the SER that no monitoring has occurred or is required because there is no history of hazardous waste, hazardous constituents, or radiological materials being managed or released at the SEA. If monitoring is taking place or has taken place, a description of the monitoring and the purpose will be provided. The nearest monitoring and production wells and sampling history will be included, if available.

4.0 SOIL EXPOSURE AND AIR PATHWAYS

4.1 Physical Conditions

This section briefly describes the physical description of the SEA, especially ground surface conditions, fencing, reference to the nearest active/occupied facilities/buildings, paved roads, etc. The location of the SEA from the nearest site boundary and a summary of site access controls is provided. A description of the SEA soil types and characteristics is provided.

4.2 Soil and Air Targets

This section identifies any soil and air targets due to soil exposure or air inhalation pathways. A description and analysis of the impact to Threatened and Endangered Species Habitats or sensitive habitats is included, if applicable.

4.3 Soil Exposure and Air Pathway Conclusions

This section identifies if there are any potential threats to human health and/or the environment and to sensitive habitats (if applicable) due to soil exposure or air pathway exposure to contaminants. A summary of the supporting soil sampling analytical results and any RSL/PRG exceedances are discussed.

5.0 SURFACE WATER PATHWAY

5.1 Hydrologic Setting

This section provides a description of the hydrologic setting for the SEA including surface water drainage, storm water flow, identification of the closest surface water or wetlands that may be impacted by the SEA, and the watershed that the SEA belongs to. If appropriate, area drainage/outfall maps are included. Probable points of entry of surface water into streams, creek, wetlands, etc., are identified. If the area is located in a facility area, the report should reference applicable National Pollutant Discharge Elimination System (NPDES) locations.

5.2 Surface Water Targets

This section identifies any surface water targets such as fisheries, Threatened and Endangered Species, wetlands, intake(s) for drinking water, or other human-related consumption (i.e., nearby farming, livestock, etc.). No fishing is permitted within the SRS.

5.3 Surface Water Conclusions

This section identifies any potential impacts to surface water or sensitive environments (as applicable).

6.0 GROUNDWATER PATHWAYS

6.1 Hydrogeological Setting

This section provides a description of the hydrogeological setting for the SEA including a discussion of the underlying soil and aquifer layers. A reference to a standard cross-section of soils with major streams noted may be included. The discussion will include the SEA elevation above mean sea level and the depth to groundwater and predicted groundwater flow direction. Potential seepage points to nearest surface waters are discussed. Groundwater information including the nearest monitoring wells and location is provided. A map showing the SEA in relation to monitoring and production/domestic wells is included, if appropriate. Well testing data may be included in an appendix, if available.

6.2 Groundwater Targets

This section identifies whether there is a viable pathway for contaminants to migrate into groundwater. Groundwater targets are defined as drinking water and production wells that may be influenced by contaminants from the SEA. This section will describe, as appropriate, whether the SEA impacts any potential water supply source.

6.3 Groundwater Conclusions

This section identifies whether the SEA has or has not impacted the groundwater considering the history, location, soil sample results, groundwater data (if available), etc.

7.0 SUMMARY AND CONCLUSION

This section describe any impacts to human health and/or the environment from the SEA. A brief review of the findings (i.e., sampling results, contaminants present, levels above screening thresholds or background levels, etc.) is included. The summary will include a statement whether radiological contamination was or was not found during the Radiological Control Survey.

Based on the information gathered, past operational history, threshold exceedances, environmental impacts, etc., the SER will conclude with a recommendation for one of the following administrative pathways.

(1) Based on the information gathered for this report, past operational history, and potential threat to human health and the environmental impacts, a recommendation is made that a more complete and formal investigation of this SEA be undertaken. The SEA will be placed on FFA Appendix C, RCRA/CERCLA List, for further evaluation under the RFI/RI Program; or

(2) The SEA poses no threat to human health and the environment and it is recommended that the SEA is placed on FFA Appendix G.2, Areas Determined to Require No Further Response Action.

8.0 REFERENCES

This section provides a list of the documents that are referred to in the SER and may include the following supporting guidance documents.[1]

Guidance for Performing Preliminary Assessments Under CERCLA, OSWER Directive 9345.0-01A, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., September 1991.

Improving Site Assessment: Integrating Removal and Remedial Site Evaluations, OSWER Directive 9360.0-39, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., April 2000.

Figures and Tables

A sample of the figures and tables to be included in the SER are listed below. Figures and tables will be specific for the SEA. Figures and tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Geographic Proximity of the SRS
Figure 2. Specific (Detailed) SEA Map
Figure 3. Location of SEA within the Watershed
Figure 4. Photograph of the SEA
Figure 5. Threatened and Endangered Species Map
Figure 6. Drainage Features and NPDES Locations
Figure 7. Nearby Groundwater Well Locations

Table 1. Soil Screening Results Table

List of Appendices

Appendices and attachments are included as appropriate. Appendices may include data tables with pertinent QA/QC information in accordance with the *Area Completion Projects Programmatic Quality Assurance Project Plan for Environmental Data Collection and Management*, ERD-AG-

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

2005-00001 (latest revision). Spill reports, soil analyses data, radiological control surveys, field notes, risk assessment details, etc., may also be included in the appendices/attachments if needed to support the evaluation.

RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION/ REMEDIAL INVESTIGATION WORK PLAN FORMAT

EXECUTIVE SUMMARY

The Executive Summary briefly summarizes the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) / Remedial Investigation (RI) Work Plan report. The Executive Summary includes a brief description of the operable unit (OU), summary of previous investigations or characterization activities if available, data quality objectives (DQOs), and data needs to define the nature and extent. The Executive Summary is consistent with the scoping summary document prepared during the RFI/RI Work Plan scoping process. The RFI is not included in the document if the OU is Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-only.

1.0 INTRODUCTION

This section presents the purpose of the RFI/RI Work Plan and a brief introduction to the OU data needs. In general, the purpose of the work plan is to present the following information: 1) the initial evaluation of existing OU data; 2) relevant OU background information; 3) the regulatory framework for the OU investigation; 4) the evaluations and decisions made during the RFI/RI Work Plan scoping process; and 5) the scope and objectives of the planned RI/Feasibility Study (FS) activities.

1.1 Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Work Plan Organization

This section provides a description of the RFI/RI Work Plan report purpose and organization with a brief description of each section and list of appendices as appropriate.

1.2 Regulatory Background

This section introduces the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) that coordinates remedial activities into one comprehensive strategy which fulfills the dual regulatory requirements of RCRA and CERCLA. The status of the OU as a RCRA/CERCLA OU or CERCLA-only OU and the applicable FFA appendix is identified.

1.3 Land Use

This section provides a description of the current land use for the area occupied by the OU as defined by the SRS Land Use Control Assurance Plan as well as any reasonable anticipated future use. This section identifies if groundwater is part of the OU or addressed separately in a groundwater OU or other OU. Figures are referenced as needed.

1.4 Summary of Operable Unit Description

This section provides a summary description of the OU history, characteristics, and setting. The OU setting includes physical location, ecological setting, geological setting, hydrological setting, demographics, and infrastructure description. OU location and layout figures are referenced.

2.0 PRELIMINARY UNIT EVALUATION

The purpose of this section is to describe and summarize existing information available for the OU.

2.1 Existing/Previous Investigations

This section provides a discussion of the history, chronology, and results of any previous investigations and/or site evaluations. Figures displaying the previous sampling locations may be referenced. Preliminary data is provided in tabular format if appropriate.

2.2 Unit Evaluation Conclusions

This section provides a discussion of whether or not the OU and surrounding media have been impacted and what, if any, additional data is required to complete the OU evaluation. Evaluation of available data (i.e., comparison to risk-based and contaminant migration thresholds) may be performed and provided in appendices to allow for better identification of problems that may warrant action and potential data gaps.

2.3 Operable Unit Strategy

This section provides a discussion of the final data needs for the OU and the anticipated strategy for investigation (e.g., GPR survey, radiological survey, soil sampling, etc.) based on the current understanding of the conceptual site model (CSM), as discussed in section 3.0, that utilizes process history and existing data. The OU strategy should align with the scoping summary document

prepared during the RFI/RI Work Plan scoping process and consider all key project decisions for the entire RI/FS process.

2.4 Potential Applicable and/or Relevant and Appropriate Requirements and To-Be-Considered Criteria

This section provides a preliminary list of the applicable or relevant and appropriate requirements (ARARs) (i.e., legally binding laws and regulations) and to-be-considered (TBC) factors (i.e., criteria, guidance, and proposed standards including United States Department of Energy Orders) for the OU. Early identification of ARARs and TBC information is used to establish preliminary remedial goals (i.e., cleanup levels) early in the RI/FS process and allows for better planning of field activities.

2.5 Potential Corrective Measures Study/Feasibility Study Options

This section provides a preliminary list of corrective measures and/or FS options (i.e., potential remedial action alternatives) that may be applicable to the OU. Identification of potential remedial action alternatives early in the process allows for the collection of supporting data.

2.5.1 Innovative Remedial Technologies

This section provides a discussion of treatability study options considered for the OU if appropriate. If potential remedial action alternatives involve treatment, then the need for treatability studies should be considered as early as possible in the RI/FS process to avoid delays at the FS stage.

2.6 Potential Early and/or Interim Remedial Actions

This section provides a discussion and a preliminary list of early and/or interim remedial actions that may be applied at the OU and their objective(s), if appropriate. Following characterization activities to support the RFI/RI Work Plan, the need for an early or interim action may be re-evaluated.

2.6.1 Early Action Strategy

Provides the justification for selecting an early or interim remedial action for the OU.

3.0 OPERABLE UNIT ASSESSMENT

3.1 Objectives

This section provides a discussion of the OU characterization objectives as they address the CSM and meet the DQO process needs.

3.2 Conceptual Site Model

The CSM is an objective framework for assessing data pertinent to the investigation. This section presents the CSM for the OU and discusses the known and suspected sources of contamination, the types of contaminants and potentially affected media, the known and potential routes of migration, and the known or potential human and environmental receptors. In addition to assisting in identifying locations where sampling is or is not necessary based on existing data, the CSM also assists in the identification of potential remedial technologies. The preliminary CSM figure(s) is referenced in this section.

3.3 Primary Source Characterization

This section provides a discussion of the specific investigation activities to be implemented and the analytical parameters to be obtained in order to characterize the primary source(s) of contamination as depicted by the CSM and as required by DQO process needs.

3.4 Secondary Source Characterization

This section provides a discussion of the specific investigation activities to be implemented and the analytical parameters to be obtained to characterize the secondary sources as depicted by the CSM and as required by DQO process needs.

3.5 Exposure Media Characterization

This section provides a discussion of the specific investigation activities to be implemented and the analytical parameters to be obtained to characterize the exposure media impacted as depicted by the CSM and as required by DQO process needs**.**

4.0 DATA QUALITY OBJECTIVES

This section introduces the DQO process. The DQO process is a series of logical planning steps that guides managers or staff to a plan for the resource-effective acquisition of environmental data. The DQO process is used to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study. The DQO steps may be presented for the OU, by subunits, or by media. The DQO table(s) are referenced.

4.1 Data Quality Objective Evaluation

4.1.1 State the Problem

This section presents a concise and detailed statement(s) of the problem(s) which will be resolved with the data being collected. This section will describe the problem, identify the general type of data needed, discuss alternative approaches to the investigation and solving the problem, and identify any constraints associated with data collection and data assessment.

4.1.2 Identify the Decisions of the Study

This section presents the study questions, alternative outcomes, and decision statements of the study. This section identifies principal study questions and defines alternative actions based on possible outcomes which result from answering the study questions, using the study question(s) and alternative actions to make a decision statement, and organizing multiple decisions into an order of priority.

4.1.3 Identify the Inputs to the Decisions

This section identifies the sources of information that will be used to answer decision statements and the basis for what will be used to guide the choices to be made later. This section identifies the types of and potential sources of information, information basis for specifying performance or acceptance criteria, and the availability of appropriate sampling and analysis methods. U.S. Environmental Protection Agency (USEPA) regional screening level (RSL)/preliminary remedial goal (PRG)/maximum contaminant level (MCL) (as appropriate) screening tables are used as the basis to guide decisions.

4.1.4 Define the Boundaries of the Study

This section defines the spatial and/or temporal boundaries of the OU. This section defines the target population, determines any spatial or temporal boundaries, identifies practical constraints, and defines the scale of inference (decision unit). The decision unit and the scale on which decisions are made are defined in this section.

4.1.5 Develop Decision Rules and Analytical Approach

This section specifies the population parameters for making decisions and develops "If-Then-Else" decision rules for the project. This section specifies the parameters considered to be important to make inferences about the target population, chooses an RSL/PRG/MCL (from Section 4.1.3) that sets the boundary between one outcome of the decision process and an alternative, and verifies if sampling and analysis methods exist that have detection limits below the risk-based threshold.

4.1.6 Specify the Limits on Decision Errors

The USEPA has developed the DQO process as the agency's recommended planning process when environmental data are used to select between two or more alternatives or to derive an estimate of contamination. This section presents the rationale for a biased sampling design if appropriate for the OU. If a statistical-based sample design is required such as for confirmation sampling, then this section will specify the decision rule(s) as a statistical hypothesis test and determine the acceptable limits on decision errors. A discussion of the performance or acceptance criteria that the data will need to achieve in order to minimize the possibility of either making erroneous conclusions or failing to maintain uncertainty estimates within acceptable levels will be included in this section. The Project Quality Objectives (PQOs) are included in this section in order for the developers of the Data Usability Report to assess whether the sampling design has achieved its quality objectives for the collected data to be qualified for project decision-making.

4.1.7 Optimize Design for Obtaining Data

This section documents the selected sampling design that will yield data that will best attain the quality objectives for the project. This section will summarize all the information from the previous steps, apply this information to identify alternative sampling designs that are appropriate for use,

and document a sampling design that will yield the data that best answers the study questions and provides sufficient data quality.

4.2 Summary of Data Quality Objective Evaluation

This section provides a summary discussion of the information developed in support of the DQO process.

5.0 SAMPLE DESIGN AND RATIONALE

This section provides a discussion of how the plan will be implemented to collect the physical data to meet the criteria developed during the DQO process. Tables listing the laboratory analytical specifications are referenced.

5.1 Rationale for Operable Unit/Media [or Facility/Media]

This section presents a description outlining the rationale for the sampling design/strategy using the CSM. This section also provides a comprehensive discussion of sample collection and how it integrates with the sample design/strategy. These are detailed statements of how the number and type of samples, the analyses performed on them, sample locations, analytical data quality, and sampling design achieve the performance and acceptance criteria.

The rationale and details of the sampling design/strategy are summarized in the DQO Worksheets for the OU, each subunit, and/or sampling media. DQO worksheets are provided for each media type (i.e., soil, sediment, surface water, groundwater, and concrete).

6.0 ANALYTICAL PLAN

This section describes the data quality levels for each type of data collected. All data collected under the work plan will follow the SRS program level *Quality Assurance Project Plan for Environmental Data Collection and Management* for the program level quality objectives, standard operating procedures, and quality assurance/quality control procedures. The data quality level is determined by the intended use of the data.

6.1 Data Quality Levels for Operable Unit/Media [or Facility/Media]

This section presents the data quality level for the OU/media [or facility/media]. Tables may be used to illustrate analytical data quality levels and its correlated quality assurance/quality control field samples. The difference between screening data and definitive data in accordance with the USEPA Uniform Federal Policy is discussed in this section.

6.2 Field Analytical Sampling Quality Assurance/Quality Control

This section references a table with the type and number of regular (soils, sediments, surface water, and groundwater) and field quality assurance (QA)/quality control (QC) samples (field duplicates, rinsate/equipment blanks, trip blanks, and split samples) required for collection in the sampling plan. The number and type of field samples can be variable depending upon the needs of the project. If there are no field QA/QC samples collected, the data is of unknown quality and will not be validated or used for remedial decision making.

6.3 Sample Matrix Table

This section references a Sampling Matrix Table to include all the below information.

A) Sample Count
B) Coordinates (may change due to field conditions)
C) Sample ID
D) Sample Number
E) Field QA/QC Samples
F) Sample Collection Method
G) Media
H) Sample Depth (depth below ground surface)
I) Subunit Location
J) Analytical Suites or analytes

The sample matrix table or text will provide a summary of the number of each type of sample collected.

6.4 Sample Location Map

This section will reference a figure that illustrates the proposed locations of samples to be collected for all matrices. Contingency/tentative sample locations are also included.

7.0 FIELD IMPLEMENTATION

7.1 List of Sampling/Collection Equipment

This section lists type of sampling/collection equipment needed to execute the Field Implementation Plan. Examples include hand augers, hand scoops, organic vapor analyzer meter, portable/hand-held pH meter, portable/hand-held conductivity meter, lanthanum-bromide (La-Br) gamma detector, global positioning system unit, KIJ5 radio, sample bottles with preservatives, and coolers. References to applicable SRS procedures are provided in this section (i.e., equipment decontamination procedures, sample documentation, chain-of-custody, sample management and shipping, and data validation and management).

7.2 Investigation Derived Waste

This section provides a statement that Investigation Derived Waste (IDW) will be managed according to the site-specific IDW management plan developed for the project and provides the reference citation to the IDW management plan.

8.0 SAFETY, HEALTH, AND EMERGENCY RESPONSE PLAN

This section provides a statement informing the reader that a unit-specific health and safety plan, in accordance with 29 CFR 1910.120 and SRS health and safety requirements, will be generated for the specific characterization activities detailed in the OU Assessment section.

9.0 SCHEDULE

This section provides a discussion of the implementation schedule. A reference to the Implementation Schedule table is made.

10.0 REFERENCES

This section provides a list of the documents that are referred to in the RFI/RI Work Plan. Examples may include data collection procedures, program level *Quality Assurance Project Plan*

for Environmental Data Collection and Management, Sampling and Analysis Plans, IDW management plan, etc., in addition to the following supporting guidance documents.[1]

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., October 1988.

Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C., February 2006.

Area Completion Projects Programmatic Quality Assurance Project Plan for Environmental Data Collection and Management, ERD-AG-2005-00001, Revision 5, Savannah River Site, Aiken, SC, 2012.

Figures and Tables

A sample of the figures and tables that may be included in the RFI/RI Work Plan are listed below. Figures and tables will be specific for the OU. Figures and tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location of the Operable Unit within the Savannah River Site
Figure 2. Layout of the Operable Unit
Figure 3. Location of Historical Samples
Figure 4. Preliminary Conceptual Site Model
Figure 5. Location of Proposed Additional Samples

Table 1. Data Quality Objectives
Table 2. Sampling Matrix Table
Table 3. Laboratory Analytical Specifications Table for TAL/TCL Analytes
Table 4. Laboratory Analytical Specifications Table for Radiological Analytes
Table 5. Minimum Field Quality Control/Quality Assurance Sampling Requirements
Table 6. Preservatives, Holding Times, and Sample Containers
Table 7. Sample Matrix
Table 8. Implementation Schedule

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

List of Appendices

A sample list of appendices to be included in the RFI/RI Work Plan is listed below.

Appendix A. Site Evaluation Results Above Method Detection Limits
Appendix B. Pre-Work Plan Characterization Data
Appendix C. Preliminary Screening Tables

This page is intentionally left blank.

RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION/ REMEDIAL INVESTIGATION/ BASELINE RISK ASSESSMENT FORMAT

EXECUTIVE SUMMARY

The Executive Summary briefly summarizes the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Remedial Investigation (RI)/Baseline Risk Assessment (BRA) report and will prepare the Core Team for validating key conclusions. The Executive Summary includes a brief description of the operable unit (OU), refined constituents of concern (RCOCs), risk assessment results, problems warranting action, remedial action objectives (RAOs), and preliminary remedial goals[1] (PRGs). The Executive Summary of the RFI/RI/BRA is consistent with the Problem Identification scoping summary for the OU. The RFI is not included in the document if the OU is Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) only.

1.0 INTRODUCTION

The purpose of following sections is to provide a discussion of the purpose and layout of the document and basic information about the OU.

1.1 Purpose and Organization of Report

This section provides a description of the RFI/RI/BRA report purpose and organization with a brief description of each section and list of appendices as appropriate.

1.2 Regulatory Background

This section introduces the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) which coordinates remedial activities into one comprehensive strategy that fulfills dual regulatory requirements of RCRA and CERCLA. The status of the OU as a RCRA/CERCLA unit or CERCLA-only unit is identified.

[1] Preliminary remedial goals were formerly known as remedial goal options in earlier SRS regulatory documentation.

1.3 Operable Unit History

This section provides a description of the OU history, location, and setting. This information is available from the OU Work Plan and is updated as necessary. Appropriate figures and tables including location maps, surface feature figures, unit summary tables, etc., are included.

1.4 Land Use

This section provides a description of the current land use for the area occupied by the OU as defined by the SRS Land Use Control Assurance Plan as well as reasonably anticipated future use. This section identifies if groundwater is part of the OU or addressed separately in a groundwater OU. Figures are referenced as needed.

1.5 Natural Resource Trustees

This section provides a brief discussion of the Natural Resource Trustees and their involvement with the project. A table that identifies the SRS Natural Resource Trustees and their responsibilities is included. Potential natural resource injuries that are suspected or known based on the conclusions of this report are documented by completion of the Natural Resource Injury Evaluation Checklist (Appendix G) and are summarized in Section 3.11.

2.0 OPERABLE UNIT DESCRIPTION

The purpose of the following sections is to provide a discussion of the physical attributes of the OU. Historical data and the data results from the OU assessment activities to ascertain physical characteristics as well as investigation activities are presented in the appropriate subsection for which the activity was conducted. (For example, geologic data gathered via cone penetrometer technology and/or coring operations could be utilized to augment the OU-specific Geology subsection). Figures and tables are referenced in each subsection as appropriate.

2.1 Physical Setting

This section provides a brief description of the OU location within the SRS (and the subunit locations within the OU if more than one exists).

2.1.1 Habitats and Ecological Setting

This section provides a description of the environmental setting of the OU that includes a description of vegetative communities, wildlife, threatened and endangered species, etc. Reference is made to a habitat map or any other surveys that may be applicable (e.g., threatened, endangered and sensitive [TES] species surveys, etc.) and/or a table of TES plant/animal species.

2.1.2 Surface Features

This section provides a description of the setting of the OU with respect to surface features (e.g., topography).

2.1.3 Meteorology

This section provides a description of the typical weather conditions for the OU. A reference to existing sources that summarize SRS weather conditions may be used instead of a detailed discussion.

2.2 Geology and Hydrogeology

This section provides a description of the OU geology, hydrogeology, surface water hydrology, and soil types.

2.2.1 Operable Unit-Specific Geology

This section provides a description of the OU-specific geology (i.e., formations). It includes historical data as well as data obtained during the investigation.

2.2.2 Operable Unit-Specific Hydrogeology

This section provides a description of the OU-specific hydrogeology (i.e., aquifers and aquitards). This section includes historical data as well as data obtained during the investigation.

2.2.3 Operable Unit Surface Water Hydrology

This section provides a description of the surface water hydrologic characteristics for the OU including wetlands, streams, etc.

2.2.4 Operable Unit Soils

This section provides a description of the soil characteristics associated with the OU that has been investigated.

2.3 Conceptual Site Model

The purpose of this section is to provide a discussion of the conceptual site model (CSM) for the OU. This includes a discussion of the known and suspected sources of contamination, the types of contaminants and potentially affected media, the known and potential routes of migration, and the known or potential human and ecological receptors (see protocol DG-2, *Exposure Pathways/Conceptual Site Model*). The components which constitute an exposure pathway are discussed in subsections and included in a CSM figure referenced in this Section. Components include:

1. Primary Sources of Contamination – this section contains a brief description of the waste(s) initially disposed of or released within the OU.
2. Primary Sources Environmental Release Mechanisms – this section describes how contaminants from the primary source enter the environment or impact secondary sources.
3. Secondary Sources of Contamination - this section identifies the environmental media contaminated by release of the primary source.
4. Secondary Sources Environmental Release Mechanisms - this section describes the processes that currently, or may in the future, release contaminants for exposure to potential receptors.
5. Exposure Media - this section identifies all media that could potentially be contaminated.
6. Exposure Routes – this section identifies the method of entry into the receptor (e.g., inhalation, ingestion, dermal contact, external radiation).
7. Receptors (Human and Ecological) – this section identifies potential future human receptors (e.g., hypothetical resident, industrial worker) as well as generic descriptions of potential ecological receptors (e.g., terrestrial or aquatic/semi-aquatic).

3.0 REMEDIAL INVESTIGATION

This section describes the collection, assessment, and evaluation of the data that identify the problem(s) warranting action from the investigation.

3.1 Operable Unit Investigation Overview

This section provides an overall discussion of the collection of data. An overview of the sampling and analysis plan(s) which were executed for this OU as part of the RFI/Feasibility Study (FS) program is included.

3.2 Site Characterization and Data Usability

This section provides a detailed description of the OU-specific investigation activities. Information about the number of samples and the type of sampling and analysis conducted to characterize CSM sources and exposure media is included. The information will also be used to describe assessment activities for each subunit within the OU as discussed in the OU-specific scoping summary document. The text will refer to Appendix A, *Investigation Data/Data Summary Tables* and Appendix H, *Data Usability Report* as appropriate.

3.3 Unit-Specific Constituent Screening

This section describes the unit-specific constituent (USC) screening process. USCs are those constituents that are likely present from unit-related activities. The text will refer to the USC Screening Tables in Appendix A (see protocol USC-1, *Unit-Specific Constituents* for the screening steps). Constituents identified as USCs are evaluated in the contaminant fate and transport analysis.

3.4 Contaminant Fate and Transport Analysis

This section provides a brief overview of the contaminant fate and transport analysis, i.e., contaminant migration (CM) analysis. The text will refer to Appendix B, *Contaminant Fate and Transport Analysis* for details.

3.5 Human Health Risk Assessment Methodology

This section provides a brief overview of the human health risk assessment (HHRA) methodology. The text will refer to Appendix C, *Human Health Risk Assessment* for details.

3.6 Ecological Risk Assessment Methodology

This section provides a brief overview of the ecological risk assessment (ERA) methodology. The text will refer to Appendix D, *Ecological Risk Assessment* for details.

3.7 Principal Threat Source Material Evaluation Methodology

This section provides a brief overview of the principal threat source material (PTSM) evaluation. The text will refer to Appendix E, *Principal Threat Source Material Evaluation* for details.

3.8 Operable Unit Subunit

This section provides a more in-depth description of the characterization, data, risk assessment results, contaminant migration results, PTSM results, etc., and is specific to an OU subunit (or exposure area). Multiple subunits or exposure areas may be presented.

3.8.1 Operable Unit Subunit Description

This section provides a more-in-depth description that is specific to this OU subunit, including physical setting, waste composition, and process history.

3.8.2 Operable Unit Subunit Characterization and Data Summary

This section provides an overview of the sampling and analysis plan which was executed for this OU subunit, including sample location map(s). The text will refer to Appendix A.

3.8.3 Operable Unit Subunit Nature and Extent of Contamination

This section describes the USCs and refers to the screening table in Appendix A. At a minimum, RCOCs (i.e., COCs that likely warrant remedial action) will be illustrated in an appropriate manner. Based on best professional judgment, other constituents/parameters that will aid in the interpretation of the OU subunit in terms of the CSM will also be illustrated, as needed.

3.8.4 Operable Unit Subunit Contaminant Fate and Transport Evaluation Results

This section provides a summary discussion of the major findings from the CM analysis. The text will refer to the presentation and interpretation of the results provided in Appendix B of the document. CM constituents of potential concern (COPCs), COCs and RCOCs are identified as appropriate.

3.8.5 Operable Unit Subunit Human Health Risk Assessment Results

This section presents a summary of the results of the HHRA. The text will refer to the detailed analysis provided in Appendix C of the document. HH COPCs, COCs and RCOCs are identified as appropriate.

3.8.6 Operable Unit Subunit Ecological Risk Assessment Results

This section presents a summary of the results of the ERA. The text will refer to the detailed analysis provided in Appendix D of the document. Constituents of potential ecological concern (COPECs), COPCs, COCs and RCOCs are identified as appropriate.

3.8.7 Operable Unit Subunit Principal Threat Source Material Evaluation Results

This section presents a summary discussion of the major findings from the PTSM analysis. The text will refer to the presentation and interpretation of the results provided in Appendix E of the document. The results of the uncertainty evaluation and a list of the PTSM RCOCs is provided.

3.8.8 Operable Unit Subunit Summary of Problems Warranting Action

This section summarizes the RCOCs for this OU subunit for the CM-, HH-, ECO-, and PTSM-based RCOCs. The problems warranting action statement(s) per the OU-specific scoping summary document are presented in this section.

3.9 Summary of Refined Constituents of Concern and Refined Conceptual Site Model

The RCOCs that warrant remedial action are summarized in this section. The preliminary CSM(s) presented in Section 2 are revised to include only the RCOCs and reviewed to determine if any other modifications are necessary to accurately depict site conditions (see protocol DG-2).

3.10 Applicable or Relevant and Appropriate Requirements Evaluation

This section compares the analytical data to the chemical-specific applicable or relevant and appropriate requirements (ARARs). Typically, this evaluation will include soil limits for polychlorinated biphenyls (PCBs) and lead; maximum contaminant limits (MCLs) and/or ambient water quality standards (AWQS) for surface waters; and MCLs for groundwater (see protocol ARAR-1, *ARAR Constituents of Concern*).

3.11 Natural Resource Injury Evaluation

This section provides a discussion of potential natural resource injuries that are suspected or known. The potential injuries are documented by completion of the checklist provided in Appendix G, *Natural Resource Injury Evaluation Checklist*. Each of the following resources are summarized, as appropriate; surface water, groundwater, air, geological, and biological.

4.0 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIAL GOALS

The purpose of this section is to provide the problems warranting action, RAOs, and uncertainties by OU subunit as presented in the OU-specific scoping summary document. This section provides documentation on the development of PRGs for the identification of potential cleanup levels. The RCOCs and PRGs will be based on key conclusions determined by the Core Team during the Problem Identification scoping meeting.

4.1 Remedial Action Objectives

The purpose of this section is to present the problem statement(s) by OU subunit as presented in the OU-specific scoping summary document. A statement that addresses the contaminants of interest for the OU will be included in this section. The RAOs are defined specifically for the problem to which they apply. The RAOs will specify the exposure pathway to be mitigated and the receptor to be protected. Key uncertainties specific to the remedial decisions identified for each OU subunit will also be presented. RAOs are typically listed in bullet form.

4.2 Preliminary Remedial Goals Development

This section describes the basis for the development of PRGs. In addition, figures are provided illustrating the locations where each of the PRGs are exceeded at the OU.

4.2.1 Contaminant Migration Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the protection of groundwater, based on the contaminant fate and transport analysis. The text will refer to Appendix F, *Preliminary Remedial Goals for the Operable Unit.*

4.2.2 Human Health Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the protection of human health. The text will refer to Appendix F. These will apply to the various media associated with the OU.

4.2.3 Ecological Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the protection of ecological receptors in the environment. The text will refer to Appendix F. These will apply to the various media associated with the OU.

4.2.4 Principal Threat Source Material Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the PTSM evaluation. The text will refer to Appendix F.

4.2.5 Applicable or Relevant and Appropriate Requirements Preliminary Remedial Goals

This section provides a discussion of the development of the PRGs for the purpose of compliance with chemical-specific ARARs. The text will refer to Appendix F.

4.3 Most Restrictive and Most Likely Preliminary Remedial Goals

A tabular listing, by media, of the PRGs based on ARARs, contaminant migration, human health risk, ecological risk, and PTSM are provided in this section. A range of background values for each media are included. From this table, the *most restrictive* PRG(s) for each media are determined based on the lowest PRG derived from the ARAR, contaminant migration, human health, ecological, and PTSM PRGs. The *most likely* PRGs will consider the land use and likely response actions as determined by the Core Team and may differ from the most restrictive PRGs. If not already provided in Section 3, figures should be provided illustrating the locations where each of the PRGs are exceeded at the OU.

5.0 SUMMARY/CONCLUSION

The purpose of this section is to provide a final succinct conclusion representative of key decisions agreed to by the Core Team during the Problem Identification scoping meeting. The conclusion section will summarize the problems warranting action, RAOs, and uncertainties by OU subunit as presented in the OU-specific scoping summary document. The intent of this section is to

summarize the conclusions of the OU-specific scoping summary document in support of the OU strategy.

5.1 Operable Unit Subunit

5.1.1 Problem Warranting Action

This section presents the problem statement(s) by OU subunit as presented in the OU-specific scoping summary document.

5.1.2 Remedial Action Objective(s)

This section presents the RAO(s) defined specifically for the problem to which they apply. The RAO(s) will be presented by OU subunit and specify the exposure pathway to be mitigated and the receptor to be protected.

5.2 Operable Unit Strategy

This section identifies the key management strategies related to achieving overall OU remediation. Key components of the strategy warranting discussion may include the identification of early actions, integration with other OUs, segregation of OU components, and modifications to project schedules and milestones based on changes in technical understanding.

6.0 IMPLEMENTATION SCHEDULE

A summary of the key deliverables and submittal dates for the OU as identified in the FFA are provided in this section. Deliverables typically include the RFI/RI/BRA Rev. 0; Corrective Measures Study/Feasibility Study, Rev. 0; Statement of Basis/Proposed Plan, Rev. 0; Record of Decision (ROD), Rev. 0; Issuance of the ROD; Corrective Measures Implementation Report/Remedial Action Completion Report, Rev. 0; Land Use Controls Implementation Plan, Rev. 0; and Remedial Action Start date. (Note: RFI/RI/BRA and CMS/FS may be combined, depending on Core Team's preferred OU strategy.)

7.0 REFERENCES

This section provides a list of the documents that are referred to in the RFI/RI/BRA and may include the following supporting guidance documents.[2]

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., October 1988.

Risk Assessment Guidance For Superfund, Volume 1, Human Health Evaluation Manual (Part A), Interim Final, EPA 540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., December 1989.

Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, OSWER Directive 9285.7-25, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., June 1997.

Guidelines for Ecological Risk Assessment. Risk Assessment Forum, EPA/630/R-95/002F, U.S. Environmental Protection Agency, Washington, D.C., April 1998.

Region 4 Ecological Risk Assessment Supplemental Guidance to ERAGS, Scientific Support Section, Superfund Division, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, March 2018.

Region 4 Human Health Risk Assessment Supplemental Guidance, Scientific Support Section, Superfund Division, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, March 2018.

Figures and Tables

A sample of the figures and tables that may be included in the RFI/RI/BRA are listed below. Figures and tables will be specific for the OU.

Figure 1. Operable Unit Location Map
Figure 2. Operable Unit Photograph
Figure 3. Comprehensive Site Features
Figure 4. Surface Topography
Figure 5. Surface Water Hydrology
Figure 6. Soil Types
Figure 7. Surface Geology

[2] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

Figure 8. Lithostratigraphic and Hydrostratigraphic Unit Comparisons
Figure 9. Groundwater Potentiometric Surface and Flow Direction Map
Figure 10. Preliminary Conceptual Site Model
Figure 11. Operable Unit Sample Locations
Figure 12. Operable Unit Threshold (e.g., PRG/RSL/MCL/AWQC) Exceedance Locations
Figure 13. Refined Conceptual Site Model

Table 1. Savannah River Site Natural Resource Trustees and Their Responsibilities
Table 2. TES Plant/Animal Species Known to Occur on SRS
Table 3. Average Temperature and Precipitation for SRS
Table 4. Preliminary Remedial Goals for the Operable Unit

List of Appendices

A sample of the appendices that may be included in the RFI/RI/BRA are listed below.

Appendix A. Investigation Data/Data Summary Tables
Appendix B. Contaminant Fate and Transport Analysis
Appendix C. Human Health Risk Assessment
Appendix D. Ecological Risk Assessment
Appendix E. Principal Threat Source Material Evaluation
Appendix F. Preliminary Remedial Goals for the Operable Unit
Appendix G. Natural Resource Injury Evaluation Checklist
Appendix H. Data Usability Report

APPENDIX A. INVESTIGATION DATA/DATA SUMMARY TABLES FORMAT

The purpose of this appendix is to provide the data used in the contaminant migration analysis, risk assessment and PTSM evaluation. If applicable, the text will refer to the electronic file that contains all of the OU characterization data in an electronic format. Data summary tables are provided for each OU subunit as applicable.

A.1 DATA SUMMARY TABLES

A.2 OPERABLE UNIT SUBUNIT 1

A.2.1 Soil Media

A.2.1.1 Surface Interval (0-1 ft interval)

(see sample Data Summary Table A-1)

A.2.1.2 Subsurface Interval (1-4 ft interval)

(see sample Data Summary Table A-1)

A.2.1.3 All Depths

(95% Upper Confidence Level on the Mean Concentration [UCL] and Reasonable Maximum Exposure [RME] columns not required)

A.2.1.4 Unit-Specific Constituent Screening Table (all depths)

(see sample USC Screening Table A-2)

A.3 OPERABLE UNIT SUBUNIT 2 (AS NEEDED)

A.3.1 Sediment Media

A.3.1.1 Surface Interval (0-1 ft interval)

(see sample Data Summary Table A-1)

A.3.1.2 All Depths

(95% UCL and RME columns not required)

A.3.1.3 Unit-Specific Constituent Screening Table (all depths)

(see sample USC Screening Table A-2)

A.3.2 Surface Water Media

A.3.2.1 Unfiltered Samples

(see sample Data Summary Table A-1)

A.3.2.2 Filtered Samples

(see sample Data Summary Table A-1)

Table A-1. SAMPLE Data Summary Table

Analyte	Units	Samples	Non-Detects	Detects	J-Detects	Distribution Code	UCL Method	Mean	95% UCL	Max	Min	RME	Max Location	Qualifier of Max	Max Date
ACETONE	mg/kg	37	25	12	8	L	3	0.004	0.00452	0.0542	ND	0.00452	FBFA-25	--	8/22/2019
ALUMINUM	mg/kg	38	0	38	3	N	1	7127.3	8105	16700	2440	8105	FBFA-13	--	7/15/2019
ANTIMONY	mg/kg	38	35	3	3	X	7	0.2002	0.353	0.541	ND	0.353	FBFA-34	J	7/24/2019
AROCLOR 1254	mg/kg	37	29	8	3	G	2	0.0065	0.0198	0.119	ND	0.0198	FBFA-19	--	7/17/2019
AROCLOR 1260	mg/kg	37	23	8	9	G	2	0.005	0.0122	0.0713	ND	0.0122	FBFA-19	--	7/17/2019
ARSENIC	mg/kg	38	0	19	19	G	2	3.68	4.526	14.5	0.586	4.526	FBFA-11	--	7/15/2019
BARIUM	mg/kg	38	0	38	1	N	1	14.25	17.07	40.7	1.24	17.07	FBFA-4	--	7/10/2019
BENZO[A]PYRENE	mg/kg	36	34	2	2	X	7	0.0076	0.0159	0.0614	ND	0.0159	FBFA-28	J	8/22/2019
BENZO[B]FLUORANTHENE	mg/kg	36	31	5	5	X	7	0.0118	0.0245	0.163	ND	0.0245	FBFA-28	J	8/22/2019
BERYLLIUM	mg/kg	38	6	32	28	X	4	0.3166	0.848	4.55	ND	0.848	FBFA-21	--	7/17/2019
CADMIUM	mg/kg	38	33	5	4	G	2	0.0963	0.196	1.03	ND	0.196	FBFA-20	--	7/17/2019
CALCIUM	mg/kg	38	0	38	5	L	3	612.7	855.4	5150	50.2	855.4	FBFA-21	--	7/17/2019
CARBAZOLE	mg/kg	36	35	1	1	--	--	0.0057	--	0.0173	ND	0.0173	FBFA-15	J	7/16/2019
CHROMIUM	mg/kg	38	0	38	3	L	3	20.61	24.79	230	3.05	24.79	FBFA-11	--	7/15/2019
CHRYSENE	mg/kg	36	34	2	2	X	7	0.0112	0.0254	0.114	ND	0.0254	FBFA-15	J	7/16/2019
COBALT	mg/kg	38	2	36	15	G	2	0.896	1.204	3.72	ND	1.204	FBFA-21	--	7/17/2019
COPPER	mg/kg	38	0	38	13	L	3	4.672	5.801	27.1	0.629	5.801	FBFA-15	--	7/16/2019
IRON	mg/kg	38	0	38	2	G	2	13341.6	16068	47200	2640	16068	FBFA-11	--	7/15/2019
LEAD	mg/kg	38	0	38	4	G	2	6.801	8.275	21.7	1.59	8.275	FBFA-20	--	7/17/2019
MAGNESIUM	mg/kg	38	0	38	3	X	4	294.8	702.1	2880	702.1	702.1	FABF-21	--	7/17/2019
MANGANESE	mg/kg	38	0	38	2	L	3	67.996	131.9	540	2.92	131.9	FABF-21	--	7/17/2019
MERCURY	mg/kg	37	2	35	12	X	4	0.0221	0.0387	0.144	ND	0.0387	FBFA-19	--	7/17/2019
NICKEL	mg/kg	38	0	38	3	G	2	2.117	2.589	8.17	0.463	2.589	FBFA-37	--	7/22/2019
POTASSIUM	mg/kg	38	0	38	1	X	4	155.3	302.8	1030	37.3	302.8	FBFA-21	--	7/17/2019
SELENIUM	mg/kg	38	31	7	4	X	7	0.9317	1.747	9.05	ND	1.747	FBFA-26	--	8/22/2019
SILVER	mg/kg	38	35	3	1	X	7	0.0904	0.177	0.743	ND	0.177	FBFA-3	--	7/11/2019
SODIUM	mg/kg	38	27	11	10	G	2	7.643	12.62	42	ND	12.62	FBFA-21	--	7/17/2019
TETRACHLOROETHYLENE (PCE)	mg/kg	37	36	1	1	--	--	0.0002	--	0.318	ND	0.0004	FBFA-15	J	7/16/2019
THALLIUM	mg/kg	38	34	4	0	X	7	1.817	3.78	23.6	ND	3.78	FBFA-26	--	8/22/2019
VANADIUM	mg/kg	38	0	38	0	G	2	39.46	49.29	187	7.17	49.29	FBFA-11	--	7/15/2019
ZINC	mg/kg	38	0	38	21	X	4	48.23	117.2	426	1.18	117.2	FBFA-20	--	7/172019
Radionuclides															
CESIUM-137	pCi/g	6	1	5	5	X	7	0.102	0.139	0.153	0.0594	0.139	FBFA-3	J	7/11/2019
COBALT-60	pCi/g	7	6	1	0	--	--	0.0375	--	0.545	ND	0.545	FBFA-21	--	7/17/2019
POTASSIUM-40	pCi/g	7	0	7	4	X	8	5.436	56.16	24.8	1.07	24.8	FBFA-21	--	7/17/2019
THORIUM-232	pCi/g	4	0	4	3	N	1	1.172	1.579	1.64	0.806	1.579	FBFA-5	--	7/11/2019
URANIUM-238	pCi/g	4	0	4	1	N	1	1.068	1.588	1.67	0.619	1.588	FBFA-21	--	7/17/2019

Distribution Code:
- N Normal Distribution
- L Lognormal Distribution
- G Gamma Distribution
- X Non-Parametric

ND = Non-Detect

UCL Method Code:
(as determined by ProUCL)
- 1 Student's t UCL
- 2 Approximate Gamma UCL
- 3 95% H-UCL
- 4 95% Chebyshev UCL
- 5 97.5% Chebysev UCL
- 6 99% Chebyshev UCL
- 7 Kaplan-Meier (KM) t UCL
- 8 Hall's Bootstrap UCL

Table A-2. SAMPLE Unit-Specific Screening Table (all depths)

ANALYTE	UNITS	Max[1] Result	Max Qualifier	Max Location	TOP DEPTH (ft)	BOTTOM DEPTH (ft)	SRS 2X Mean Background[2]	Is Max Detect > 2X SRS Mean Bkg?[3]
Inorganics								
ALUMINUM	mg/kg	35700.0		FBFA-17	28	30	13395	Yes
ANTIMONY	mg/kg	2.40	J	FBFA-7	1	4	2.653	No
ARSENIC	mg/kg	14.50		FBFA-11	0	1	4.453	Yes
BARIUM	mg/kg	62.10		FBFA-4	1	4	33.108	Yes
BERYLLIUM	mg/kg	4.550		FBFA-21	0	1	0.305	Yes
CADMIUM	mg/kg	1.030		FBFA-20	0	1	0.444	Yes
CALCIUM	mg/kg	5150.0		FBFA-21	0	1	334	Yes
CHROMIUM	mg/kg	230.0		FBFA-11	0	1	22.868	Yes
COBALT	mg/kg	9.450		FBFA-17	28	30	1.396	Yes
COPPER	mg/kg	468.0		FBFA-37	1	4	6.352	Yes
IRON	mg/kg	47200.0		FBFA-11	0	1	22001	Yes
LEAD	mg/kg	21.70		FBFA-20	0	1	10.825	Yes
MAGNESIUM	mg/kg	2880.0		FBFA-21	0	1	245.69	Yes
MANGANESE	mg/kg	540.0		FBFA-21	0	1	63.277	Yes
MERCURY	mg/kg	0.1440		FBFA-19	0	1	0.067	Yes
NICKEL	mg/kg	17.20		FBFA-17	28	30	4.154	Yes
POTASSIUM	mg/kg	2170.0		FBFA-17	28	30	213.034	Yes
SELENIUM	mg/kg	26.20		FBFA-38	8	10	3.706	Yes
SILVER	mg/kg	0.7430		FBFA-3	0	1	0.637	Yes
SODIUM	mg/kg	42.0	J	FBFA-17	28	30	43.555	No
THALLIUM	mg/kg	55.10		FBFA-38	8	10	2.936	Yes
VANADIUM	mg/kg	187.0		FBFA-11	0	1	58.060	Yes
ZINC	mg/kg	426.0		FBFA-20	0	1	7.440	Yes
Polychlorinated Biphenyls (PCBs)								
AROCLOR 1254	mg/kg	0.1190		FBFA-19	0	1	N/A	Yes
AROCLOR 1260	mg/kg	0.07130		FBFA-19	0	1	N/A	Yes
Volatile Organic Compounds								
ACETONE	mg/kg	0.08530		FBFA-26	1	4	N/A	Yes
TETRACHLOROETHYLENE (PCE)	mg/kg	0.000720	J	FBFA-18	1	4	N/A	Yes
TRICHLOROETHYLENE (TCE)	mg/kg	0.001450		FBFA-17	28	30	N/A	Yes
Semi-Volatile Organic Compounds								
BENZO[A]PYRENE	mg/kg	0.06140	J	FBFA-28	0	1	N/A	Yes
BENZO[B]FLUORANTHENE	mg/kg	0.16300	J	FBFA-28	0	1	N/A	Yes
CARBAZOLE	mg/kg	0.01730	J	FBFA-15	0	1	N/A	Yes
Radionuclides								
CESIUM-137	pCi/g	0.1530	J	FBFA-3	0	1	0.093	Yes
COBALT-60	pCi/g	0.5450		FBFA-21	0	1	N/A	Yes
POTASSIUM-40	pCi/g	24.80		FBFA-21	0	1	2.519	Yes
THORIUM-232	pCi/g	3.970		FBFA-7	28	30	2.085	Yes
URANIUM-238	pCi/g	2.570		FBFA-7	28	30	1.009	Yes
Table Notes:								
J = estimated value.								
NA = not available.								
1 = Max = maximum detected concentration from all depth intervals.								
2 = *Background Soils Statistical Summary Report for the Savannah River Site* , ERD-EN-2005-0223, Appendix B-2 (All Depth Intervals).								
3 = Constituents identified as an USC if maximum detected concentration is greater than 2X SRS Mean Concentration.								

APPENDIX B. CONTAMINANT FATE AND TRANSPORT ANALYSIS FORMAT

The purpose of this appendix is to provide a discussion of the contaminant fate and transport analysis of the operable unit (OU). The analysis of the contaminant migration (CM) through the soil to underlying groundwater is described in detail. For OU contaminants predicted to exceed the maximum contaminant levels (MCLs) in groundwater by overly conservative CM calculations, detailed groundwater modeling may be appropriate. If groundwater modeling is performed, a summary discussion of the groundwater modeling is provided in this appendix. Results of the CM analysis will be discussed with the Core Team at the Problem Identification Scoping Meeting.

B.1 INTRODUCTION

This section describes the types of CM analyses performed and the rationale for providing those analyses. Soil unit-specific constituents (USCs) identified in Section 3 are analyzed using the CM analysis protocols (Module 5) for their potential to contaminate underlying groundwater and pose a threat to human health or the environment. Typically the fate and transport analysis is performed using the spreadsheet Vadose Zone Contaminant Migration Multi-Layered (VZCOMML©) modeling program, which accounts for decay processes, infiltration rate, soil properties, vadose zone thickness and chemical behavior.

B.2 CONTAMINANT MIGRATION MODEL

B.2.1 Background

The OU description provided in Section 1.3 and the data discussion provided in Section 3.2 is summarized. The text refers to information in Appendix A, *Investigation Data/ Data Summary Tables*.

B.2.2 Screening Methods

This section describes screening methods for identifying CM constituents of potential concern (COPCs) and CM constituents of concern (COCs) using the VZCOMML© modeling program (see protocols CM-1, *CM Model (VZCOMML)* and CM-2, *CM Constituents of Concern*).

B.2.3 Soil Screening Equations

This section describes the equations used by the VZCOMML© modeling program for the soil screening process. A conceptual framework of the model, the vadose zone, and screening parameters is provided in a figure. Equations for dilution attenuation factor, soil screening limits, mean travel time, saturation concentration and groundwater concentration are provided.

B.2.4 Modeling Parameters

This section presents the steps for performing the CM simulations facilitated by the VZCOMML© modeling program and provides a discussion and the rationale for the selection of vadose zone layers, chemical parameters, and physical parameters for each OU subunit.

B.2.5 Results of Tier I and Tier II Analyses

This section describes the results of the Tier I (CM COPCs) and Tier II (CM COCs) screening for each OU subunit. Rationale for modification to VZCOMML© modeling program inputs throughout the screening simulations is provided. Summary tables of the Tier I and Tier II results are provided as appropriate.

B.2.6 Uncertainty Discussion

This section provides an uncertainty evaluation for COCs per the *Constituents of Concern (COC) Refinement Process Protocol* (COC-1) to determine the final CM RCOCs. The text will refer to the tables from Step B.2.5 as appropriate. A discussion of the uncertainty inherently associated with the CM analysis is included as appropriate.

B.2.7 Supplemental Modeling (if needed)

An additional, more robust fate and transport model (e.g., GoldSim) may be used to further evaluate transport of certain constituents. Rationale for performing supplemental modeling is provided. The supplemental model, inputs, and results are described in this section.

B.3 SUMMARY/CONCLUSIONS OF THE CONTAMINANT MIGRATION ANALYSIS

This section provides the overall summary of the CM analysis by OU subunit, as appropriate. The final CM RCOCs are identified and reference is made to the refined conceptual site model presented in Section 3.

B.4 REFERENCES

This section provides a list of references that are cited in the CM analysis.

Figures and Tables

A sample list of figures and tables to be included in the CM analysis is provided below.

Figure B-1. OU Sample Location Map
Figure B-2. VZCOMML© Contaminant Migration Conceptual Diagram

Table B-1. Chemical Parameters Used for Screening
Table B-2. Vadose Zone Layers
Table B-3. Physical Parameters Used for Screening
Table B-4. Tier I Screening Results
Table B-5. Tier II Simulation Results
Table B-6. Summary Table of Tier I and Tier II Results

This page is intentionally left blank.

APPENDIX C. HUMAN HEALTH RISK ASSESSMENT FORMAT

The purpose of this appendix is to provide documentation of the analysis of the potential for adverse human health effects associated with exposure to unit-related contaminants likely to be present at the operable unit (OU). Baseline human health (HH) risks are those risks to HH that can be anticipated in the absence of any remedial efforts or institutional controls for the unit. Exposure groups and receptors evaluated will be consistent with the key decisions agreed to by the Core Team at the Post Characterization Scoping Meeting prior to the implementation of RFI/RI/BRA protocols. Results of the human health risk assessment (HHRA) will be presented to the Core Team at the Problem Identification Scoping Meeting.

C.1 INTRODUCTION

This section provides a brief explanation of the purpose of the BRA and discusses the organization of the HHRA appendix. Typically, a streamlined approach that considers standard receptors/ exposure assumptions is used for this evaluation.

C.1.1 Background

This section summarizes the OU description provided in Section 1.3.

C.1.2 Data

This section summarizes the data discussion provided in Section 3.2 and refers to information in Appendix A, *Investigation Data/Data Summary Tables*.

C.1.3 Receptors and Exposure Scenarios

This section provides a description of the receptors and exposure scenarios evaluated in the HHRA (see protocol HH-2*, Human Health Receptors and Scenarios* and protocol HH-3, *Human Health Reasonable Maximum Exposure Parameters*).

C.1.4 Sources of Risk-Based Threshold Values

This section provides a description of the sources of the HH risk-based threshold values, i.e., United States Environmental Protection Agency (USEPA) regional screening levels (RSLs), preliminary remediation goals (PRGs), preliminary remediation goals for outdoor surfaces (SPRGs), and preliminary remediation goals for buildings (BPRGs) websites as appropriate. The

USEPA tables and calculator function inputs/ outputs are provided as attachments to this appendix, including tables for any unit-specific receptors (see protocol HH-1, *Sources of Human Health Screening Values*).

C.2 HUMAN HEALTH RISK ASSESSMENT PROCESS

The purpose of this section is to describe the methodology used to identify HH constituents of potential concern (COPCs), constituents of concern (COCs) and refined constituents of concern (RCOCs) for the media of concern (soil, sediment, concrete, surface water, groundwater, etc.).

C.2.1 Soil, Sediment, or Concrete Media

C.2.1.1 Constituents of Potential Concern Screening

The process to identify HH COPCs is summarized in this section. A COPC screening table is provided (see protocol HH-4, *Human Health Constituents of Potential Concern*).

C.2.1.2 Risk/Hazard Calculation

The process to identify HH COCs is summarized in this section. A risk/hazard calculation is typically provided for the resident and industrial worker exposure scenarios (additional receptors as appropriate). A Risk/Hazard Calculation table is provided (see protocol HH-5, *Human Health Constituents of Concern*).

C.2.2 Groundwater or Surface Water Media

C.2.2.1 Comparison to MCL or RSL/PRG or AWQC

The process to screen surface water or groundwater media is described in this section. A formal risk calculation is not presented, rather a comparison to maximum contaminant levels (MCLs), RSLs/PRGs, or AWQCs is provided. For groundwater, the maximum detected concentrations of each constituent are compared to drinking water MCLs. In the absence of an MCL, the tap water RSL/PRG is used as a screening threshold.

For surface water, the maximum detected concentrations of each constituent is compared to the drinking water MCLs and ambient water quality criteria (AWQC, Consumption of Water plus Organism). In the absence of an MCL or AWQC, the tap water RSL/PRG is used as a screening

threshold. A comparison table to the screening criteria is provided (see protocol HH-4, *Human Health Constituents of Potential Concern*).

C.2.3 Results/Refinement of Constituents of Concern

This section presents the uncertainty evaluation for COCs per the *Constituents of Concern (COC) Refinement Process Protocol* (COC-1). Discussion is provided for each OU subunit. The text will refer to tables from Steps C.2.1 and C.2.2 as appropriate. A weight of evidence evaluation for any additional considerations (e.g., radioactive decay [recalculate risk for drivers], consideration of other background data, SRS Background for soil, filtered vs. unfiltered water samples, average concentration vs. maximum concentration for surface water, etc.) is included. A recommendation on whether a constituent is a problem warranting action (i.e., identified as an RCOC) for each media type is provided.

C.3 SUMMARY CONCLUSION OF THE HUMAN HEALTH RISK ASSESSMENT

This section is an overall summary of the HHRA results by OU subunit. RCOCs and corresponding risk/hazard levels for each receptor evaluated are identified. The text will refer to the refined conceptual site model presented in Section 3.

C.4 REFERENCES

This section provides a list of the references that are cited in the HHRA.

Figures and Tables

A sample list of figures and tables to be included in the HHRA is provided below.

Figure C-1. Operable Unit Sample Location Map

Table C-1. Human Health COPC Screening for OU Subunit
Table C-2. Human Health Risk/Hazard Calculation for OU Subunit

List of Attachments

A sample list of attachments to be included in the HHRA is provided below.

Attachment C-1: USEPA Regional Screening Levels Table: RSLs for Default Resident and Default Industrial Worker Scenarios *(website accessed date)*

Attachment C-2: USEPA Radionuclide Preliminary Remedial Goals for Superfund Website: Site-Specific PRGs for Residential Scenario *(website accessed date)*

Attachment C-3: USEPA Radionuclide Preliminary Remedial Goals for Superfund Website: Default PRGs for Industrial Worker Scenario *(website accessed date)*

Attachment C-4: MCLs/AWQC/RSLs for Surface Water Data Screening of Nonradiological Constituents

Attachment C-5: MCLs/PRGs for Surface Water Data Screening of Radiological Constituents

APPENDIX D. ECOLOGICAL RISK ASSESSMENT FORMAT

The purpose of this appendix is to provide documentation of the analysis of the potential for adverse ecological effects associated with exposure to unit-related contaminants likely to be present at the operable unit (OU). The ecological risk assessment (ERA) consists of steps designed to provide a scientifically based and defensible evaluation of exposure and hazard to ecological resources that will support a risk management decision regarding site remediation. Ecological (ECO) risk is associated with the potential for harmful effects to ecological systems resulting from exposure to an environmental stressor. A stressor is any physical, chemical, or biological entity that induces an environmental response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact. Exposure groups and receptors evaluated will be consistent with the key decisions agreed to by the Core Team at the Post Characterization Scoping Meeting prior to the implementation of RFI/RI/BRA protocols. Results of the ERA will be presented to the Core Team at the Problem Identification scoping meeting.

The first step in the process involves a qualitative evaluation regarding the potential for ECO impacts by performing a unit reconnaissance. If a survey of the area concludes that the physical setting of the OU does not provide adequate habitat for community level impacts to wildlife receptors since it is located in an industrial setting or it is very small in size, then further ecological evaluation is not warranted.

D.1 INTRODUCTION

This section provides a brief explanation of the purpose of the BRA and discusses the organization of the ERA appendix.

D.1.1 Background

This section summarizes the OU description provided in Section 1.3.

D.1.2 Data

This section summarizes the data discussion provided in Section 3.2 and refers to information in Appendix A, *Investigation Data/Data Summary Tables*.

D.1.3 Habitats/Receptors/Preliminary Assessment and Measurement Endpoints

This section provides a summary description of the environmental setting of the OU provided in Section 2.1.1 that includes a description of vegetative communities, wildlife receptors, threatened, endangered and sensitive (TES) species, etc. Preliminary assessment and measurement endpoints are discussed (see protocol ECO-2, *Ecological Receptors and Measurement/Assessment Endpoints*).

D.1.4 Sources of Literature-Based Threshold Values

Thresholds to be used in the OU data screening steps will be based on several sources as indicated in protocol ECO-1, *Sources of Ecological Screening and Refinement Values.* A master table that compares the values from each of the sources and identifies the value to be used in the data screening effort is presented. A *Derivation of Screening and Refinement Values* table is included as an attachment.

D.2 ECOLOGICAL RISK ASSESSMENT PROCESS

The purpose of this section is to describe the methodology used to identify constituents of potential ecological concern (COPECs), constituents of potential concern (COPCs), constituents of concern (COCs), and refined constituents of concern (RCOCs) for the media of concern (i.e., soil, sediment, and/or surface water).

D.2.1 Screening-Level Effects Evaluation

The screening-level effects evaluation identifies the potential for adverse ecological effects based on conservative assumptions. The process to identify COPECs is summarized in this section. No observable adverse effects level (NOAEL)-based ecological screening values (ESVs) are used as screening-level effects thresholds to calculate a hazard quotient (HQ) using the maximum detected concentration (see protocol ECO-3, *Constituents of Potential Ecological Concern*).

D.2.1.1 Soil, Sediment or Surface Water Media

The process to identify COPECs for each OU media type is summarized in this section. A COPEC screening table is provided (see protocol ECO-3).

D.2.2 Refinement-Level Risk (Hazard) Calculation

The refinement-level risk calculation further focuses on the potential for adverse ecological effects based on less conservative exposure assumptions. The process to identify ECO COPCs is summarized in this section. Lowest observable adverse effects level (LOAEL)- based refinement screening values (RSVs) are used as refinement-level effects thresholds to calculate a HQ using the 95% upper confidence level on the mean concentration (95%UCL) (see protocol ECO-4, *Ecological Constituents of Potential Concern/Constituents of Concern*).

D.2.2.1 Soil, Sediment or Surface Water Media

The process to identify ECO COPCs for each OU media type is summarized in this section. A Refinement-Level Evaluation table is provided (see protocol ECO-4). If additional site-specific data/studies are not warranted, then the COPC analytes are identified as COCs and carried forward to the uncertainty discussion.

D.2.3 Results/Refinement of Constituents of Potential Concern

This section provides an uncertainty evaluation (i.e., weight of evidence) for COPCs/COCs per the *Constituents of Concern (COC) Refinement Process Protocol* (COC-1). Discussion is provided for each OU subunit. The text will refer to tables from Steps D.2.1 and D.2.2 as appropriate. HQ calculations for all receptors that pertain to the RSV exceedance from Section D.2.2 are provided. HQs are adjusted based on population area use factors (PAUF) and mean concentration, if appropriate, and the adjusted HQ calculation is included as an attachment. A weight of evidence evaluation for additional considerations (e.g., other background data, SRS Background for soil, radioactive decay [recalculate risk], unfiltered vs. filtered water samples, etc.) is included as appropriate. A recommendation whether the constituent is a potential problem warranting action for each media type, and/or data gaps that need to be addressed through site-specific biological sampling is provided in this section. If additional ecological/biological studies are not warranted, then the COCs that have been retained in the refinement process are identified as RCOCs.

D.2.4 Screening and Refinement Level Ecological Effects Conclusion

This section summarizes the COPCs/COCs and habitats and environmental media of concern, receptors of concern, exposure pathways, assessment endpoints and risk questions to be addressed

by biological sampling. A determination is made if site-specific ecological studies or other biological data may be needed to address uncertainty associated with using literature-based values only at this stage of the ERA process and whether or not a remedial decision can be made from an ecological risk perspective. If additional studies are not warranted, then the process is complete.

D.2.5 Site-Specific Biological Sampling (if needed)

If deemed appropriate, this section outlines the ECO studies that address the COPCs. This may include further soil/sediment/surface water sampling, trophic modeling, bioaccumulation/ tissue residue studies, toxicity testing, and/or population or community evaluations are the methodologies most commonly used (see protocol ECO-5, *Ecological Site-Specific Data/Studies*).

D.2.6 Additional Risk Information and Uncertainty Evaluation (if needed)

This section discusses the results of the site-specific biological sampling effort and identifies constituents that exceed thresholds as COCs. An additional uncertainty evaluation of the COCs results in the identification of RCOCs as problems warranting remedial action.

D.3 SUMMARY/CONCLUSIONS OF THE ECOLOGICAL RISK ASSESSMENT

This section is an overall summary of the ERA results by OU subunit. RCOCs and corresponding HQs for ecological niches/receptors of concern are identified. The text will refer to the refined conceptual site model presented in Section 3.

D.4 REFERENCES

This section provides a list of references that are cited in the ERA.

Figures and Tables

A sample list of figures and tables to be included in the ERA is provided below.

Figure D-1. Operable Unit Sample Location Map

Table D-1. Screening Level Evaluation for OU Subunit
Table D-2. Refinement Level Evaluation for OU Subunit

List of Attachments

A sample list of attachments to be included in the ERA is provided below.

Attachment D-1: Derivation of Operable Unit Ecological Screening Values (ESVs) and Refinement Screening Values (RSVs)

Attachment D-2: EPA Region 4 Screening Tables for Soil, Sediment, and Surface Water

Attachment D-3: Los Alamos National Laboratory ECORISK Database table of No Effects Ecological Screening Levels and Low Effects Ecological Screening Levels

Attachment D-4: South Carolina Department of Health and Environmental Control, R.61-68, Water Classifications and Standards, table for protection of freshwater aquatic life

Attachment D-5: Uncertainty Tables/PAUF-Adjusted Hazard Quotients

Attachment D-6: Site-Specific Biological Sampling Information (as needed)

- TES Survey Report
- Trophic-Level Modeling Report
- Toxicity Test Results
- Community Surveys
- Other pertinent studies, etc. (e.g., Savannah River Ecology Laboratory)

This page is intentionally left blank.

APPENDIX E. PRINCIPAL THREAT SOURCE MATERIAL EVALUATION FORMAT

The purpose of this appendix is to provide documentation of the principal threat source material (PTSM) evaluation. Exposure groups and receptors evaluated will be consistent with the key decisions agreed to by the Core Team at the Post Characterization Scoping Meeting prior to the implementation of RFI/RI/BRA protocols. Results of the PTSM evaluation will be presented to the Core Team at the Problem Identification scoping meeting.

E.1 INTRODUCTION

This section provides a brief explanation of the concept and determination of principal threat waste as developed by United States Environmental Protection Agency (USEPA) and implemented at the Savanah River Site.

E.1.1 Background

This section summarizes the unit description provided in Section 1.3.

E.1.2 Data

This section summarizes the data discussion provided in Section 3.2 and refers to information in Appendix A, *Investigation Data/Data Summary Tables*.

E.1.3 Receptor

This section provides a description of the receptor evaluated in the PTSM evaluation (see protocol HH-7, *Evaluation of Principal Threat Source Material [PTSM] at SRS Waste Units*).

E.1.4 Sources of Risk-Based Threshold Values

This section provides a description of the sources of the risk-based threshold values, i.e., USEPA regional screening levels (RSLs), preliminary remediation goals (PRGs), preliminary remediation goals for outdoor surfaces (SPRGs), and preliminary remediation goals for buildings (BPRGs) websites as appropriate. A copy of the USEPA tables/ calculator function inputs and outputs as attachments to this appendix, including tables for any unit-specific receptors is provided (see protocol HH-1, *Sources of Human Health Screening Values*).

E.2 PRINCIPAL THREAT SOURCE MATERIAL EVALUATION PROCESS

The process to identify PTSM is summarized in this section (see protocol HH-7). The source material is preliminarily considered to be PTSM if the cumulative risk exceeds one of the following toxicity threshold criteria:

- Carcinogens - greater than 1E-03 industrial worker risk
- Noncarcinogens – industrial worker hazard index (HI) greater than 10

E.2.1 Screening Evaluation

In the preliminary screen, the unit maximum for every detected constituent (soil, sediment or concrete media as applicable) from all depth intervals is determined and used as the exposure point concentration (EPC) for the risk/hazard calculation. A PTSM Screening Evaluation Table is provided.

E.2.2 Refined Calculation (if needed)

This section presents a refined calculation of risk/hazard using a 95% upper confidence limit on the mean concentration (95%UCL) as the EPC for the constituents that exceed the initial screening evaluation.

E.2.3 Results/Refinement of Constituents of Concern

This section provides an uncertainty evaluation (i.e., weight of evidence) for COCs per the protocol COC-1, *Constituents of Concern (COC) Refinement Process.* The text will refer to tables from Step E.2.1. and E.2.2 as appropriate. A weight of evidence evaluation for any additional considerations is included. Some examples where it may not be appropriate to identify the source term as PTSM include: 1) if the source defined as PTSM is of very limited extent or volume, 2) if the source term appears skewed based on a single value, 3) if a published toxicity value is undergoing additional evaluation, or 4) if the HI exceeds 10 based on the cumulative effects of noncarcinogens that effect different target organs.

E.3 SUMMARY/CONCLUSION OF THE PRINCIPAL THREAT SOURCE MATERIAL EVALUATION

This section is an overall summary of the PTSM evaluation. The refined constituents of concern and corresponding risk hazard/hazard levels for the receptor are identified and reference is made to the refined conceptual site model presented in Section 3.

E.4 REFERENCES

This section provides a list of references that are cited in the PTSM evaluation.

Figures and Tables

A sample list of figures and tables to be included in the PTSM evaluation is provided below.

Figure E-1. Operable Unit Sample Location Map

Table E-1. PTSM Screening Evaluation (all depth intervals)

List of Attachments

Attachment E-1: USEPA Regional Screening Levels Table: RSLs for Default Industrial Worker Scenario *(website accessed date)*

Attachment E-2: USEPA Radionuclide Preliminary Remedial Goals for Superfund Table: PRGs for Default Industrial Worker Scenario *(website accessed date)*

This page is intentionally left blank.

APPENDIX F. PRELIMINARY REMEDIAL GOALS FOR THE OPERABLE UNIT FORMAT

F.1 INTRODUCTION

The purpose of this appendix is to present the preliminary remedial goals (PRGs) for the operable unit (OU). PRGs are potential cleanup levels that are identified/calculated for all of the refined constituents of concern that are problems warranting action. PRG summary tables are included if appropriate.

F.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS PRELIMINARY REMEDIAL GOALS

This section presents the ARAR PRGs for the OU. Chemical-specific ARARs are presented in Section 3 of this document (see protocol ARAR-2, *ARAR Preliminary Remedial Goals*).

F.3 CONTAMINANT MIGRATION PRELIMINARY REMEDIAL GOALS

This section presents the contaminant migration (CM) PRGs for the OU. The CM analysis is presented in Appendix B, *Contaminant Fate and Transport Analysis*, of this document (see protocol CM-3, *Contaminant Migration PRGs*).

F.4 HUMAN HEALTH PRELIMINARY REMEDIAL GOALS

This section presents the human health (HH) PRGs for the OU. The HH risk assessment is presented in Appendix C, *Human Health Risk Assessment*, of this document (see protocol HH-6, *Human Health PRGs*).

F.5 ECOLOGICAL PRELIMINARY REMEDIAL GOALS

This section presents the ecological PRGs for the OU. The ecological risk assessment is presented in Appendix D, *Ecological Risk Assessment*, of this document (see protocol ECO-6, *Ecological PRGs*).

F.6 PRINCIPAL THREAT SOURCE MATERIAL PRELIMINARY REMEDIAL GOALS

This section presents the principal threat source material (PTSM) PRGs for the OU. The evaluation is presented in Appendix E, *Principal Threat Source Material Evaluation*, of this document. PTSM PRGs are established at the 1E-03 risk level or hazard quotient = 10.

APPENDIX G. NATURAL RESOURCE INJURY EVALUATION CHECKLIST FORMAT

The Natural Resource Injury Evaluation Checklist is provided to assist project teams in determining the potential for natural resource injuries in the conduct and planning of remedial activities. For the most part, the questions only require a simple 'yes/no' or 'to be determined' response. Some require a short answer or explanation. However, it is in the best interest of the project team to be as complete as possible and add any relevant information.

Four main areas are evaluated, as follows:

- Are there potential natural resource injuries and what do they consist of?
- What are the potential impacts from implementing the remedial alternatives?
- Are there potential residual injuries that will not be addressed by the alternative?
- What potential irreversible and irretrievable resources may be identified?

The checklist shown below should be re-visited and revised as CERCLA/RCRA activities continue and additional information becomes available.

1. Has a release of a hazardous substance occurred?

2a. Have natural resources for which federal or state agencies (or Indian Tribes) may assert trusteeship under CERCLA been or are likely to have been adversely affected by the release?

Natural resources are defined by Section 101(16) of CERCLA, as "land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources". The National Contingency Plan (NCP) Section 300.600(b) indicates that natural resources may include not only the environmental organisms and abiotic resources, but the "supporting ecosystems associated with the biotic resources" as well. Resources are categorized into five groups: surface water resources, groundwater resources, air resources, geologic resources, and biological resources. Resources can also be classified as direct use (such as drinking water, hunting, etc.) or nonuse (such as aesthetic value or existence). Nonuse services do not require physical or visual contact between people and the resource. Nonuse resources include resources that provide well-being for people (or other flora/fauna) because they exist. For example, nesting sites, threatened and endangered species, natural areas, etc.

2b. List the potentially affected resources (e.g., ground water, waterfowl, etc.).

3. Is the amount of hazardous substance released sufficient to potentially cause a natural resource injury?
4. Will the remedial alternatives being considered, or action already taken, sufficiently address the injuries to natural resources (including residual injuries)?
5. Will the remedial alternatives being considered produce additional impacts to natural resources during remediation? If yes, the potential impacts associated with each alternative need to be identified and discussed in the appropriate documentation including the Feasibility Study, Statement of Basis/Proposed Plan, Record of Decision or permit modification.

The potential costs for addressing resource injuries should be taken into consideration when selecting a remedial alternative. The liability (potential damages) associated with resource injuries could drive the cost of the intended best or lowest cost alternative.

6. Identify any irreversible and/or irretrievable resource losses in the appropriate documentation.

APPENDIX H. DATA USABILITY REPORT

The purpose of this appendix is to present the analytical data verification and validation results for the sample events associated with the operable unit. The Data Usability Report is prepared per F-15, *Data Usability Report Format*, and may be submitted separately.

This page is intentionally left blank.

CORRECTIVE MEASURES STUDY/FEASIBILITY STUDY FORMAT

EXECUTIVE SUMMARY

The Executive Summary briefly summarizes the Corrective Measure Study (CMS)/Feasibility Study (FS) report prepared for Resource Conservation Recovery Act (RCRA) and/or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) operable units (OUs). The Executive Summary includes a brief description of the OU and refined constituents of concern (RCOCs), remedial action objectives (RAOs), and remedial alternatives evaluated. The CMS is not included in the document if the OU is CERCLA only.

1.0 INTRODUCTION

The purpose of the CMS/FS report is to present the development, screening, and detailed analysis of remedial alternatives to support the Core Team in the selection of a remedy for the OU. The Introduction section provides a brief description of the Savannah River Site and an introduction to the OU including the media of concern and contaminants. The following subsections describe the purpose of the CMS/FS report and provide a basic understanding of the OU including background information and previous evaluations.

1.1 Purpose and Organization of Report

A description of the purpose of the CMS/FS report and the organization of the report is provided. A reference to the more extensive information available in the RCRA Facility Investigation (RFI)/Remedial Investigation (RI)/Baseline Risk Assessment (BRA) report is included.

1.2 Operable Unit Background

This section provides a summary of the information available to provide a basic understanding of the OU, the history of the OU, and a discussion of the contamination that has resulted from activities that occurred at the OU. A summary of the conclusions of the BRA and fate and transport analysis is provided as appropriate.

1.2.1 Operable Unit Description

A brief description of the OU is provided including its location, size, geography, and environmental setting. OU location and layout figures are referenced. For evaluation purposes, the OU may be segregated into subunits.

1.2.2 Operable Unit History

A brief description of the activities (i.e., processes, uses, cleanup activities, etc.) that have taken place at the OU are provided to support the understanding of the nature and extent of contamination.

1.2.3 Nature and Extent of Contamination

The purpose of this section is to provide a discussion of the media of concern and contamination that resulted from activities at the OU. A schematic cross section figure showing the contamination is provided.

1.2.4 Contaminant Fate and Transport

A discussion of the mobility, in-growth, and decay of the OU contaminants is provided if appropriate. The contaminant fate and transport summary will identify the contaminant migration RCOCs that require a response action. A figure showing the Conceptual Site Model (CSM) is provided.

1.2.5 Baseline Risk Assessment

A summary of the RFI/RI/BRA is included. The summary will identify the RCOCs that require a response action and the estimated risks to potential receptors. A reference to the more extensive information available in the RFI/RI/BRA report is included.

1.2.6 Problems Warranting Action

All specific problems related to human health or ecological risk, contaminant migration, PTSM, or exceedance of an ARAR that are determined by the Core Team to warrant a response action are presented concisely. Bullet form is acceptable.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The purpose of this section is to provide a description of the general response actions for the OU, identify potential remedial technologies for each general response action, and screen remedial technologies with respect to National Contingency Plan (NCP) criteria: effectiveness, implementability and cost. The initial list of action technologies applicable to the OU is typically based on the approved likely response actions from prior scoping meetings with USDOE, USEPA and SCDHEC, as well as experience with similar response actions. This section will be significantly streamlined for focused CMS/FS reports.

2.1 Remedial Action Objectives

The purpose of this section is to present the problem statement(s) by OU subunit as presented in the OU-specific scoping summary document. A statement that addresses the contaminants of interest for the OU will be included in this section. The RAOs are defined specifically for the problem to which they apply. The RAOs will specify the exposure pathway to be mitigated and the receptor to be protected. Key uncertainties specific to the remedial decisions identified for each OU subunit will also be presented. RAOs are typically listed in bullet form.

2.1.1 Allowable Exposure Based on Risk Assessment

A summary of the regulatory guidelines governing the development of risk-based contaminant levels is provided including the target risk range and applicable or relevant and appropriate requirements (ARARs).

2.1.2 Development of Preliminary Remedial Goals

This section provides a description of how the Preliminary Remedial Goals[1] (PRGs) were developed for the identification of potential cleanup levels. A reference to the table of PRGs for the OU is included. In addition, figures may be provided illustrating the locations where each of the PRGs are exceeded at the OU.

[1] Preliminary remedial goals were formerly known as remedial goal options in earlier SRS regulatory documentation.

2.2 General Response Actions

The purpose of this section is to describe the OU-specific actions that achieve the RAOs and satisfy the requirements of the NCP for each problem warranting action. General response actions may include treatment, containment, excavation, extraction, disposal, institutional actions, or a combination of these. For each medium of interest, a description of the estimated area or volume where treatment, containment, or exposure technologies may be applied is provided.

2.3 Identification and Evaluation of Technology Types and Process Options

A description of the universe of potentially applicable technology types and process options is provided. An evaluation of how reasonable the use of the technologies will be at the OU using the broad categories of effectiveness, implementability, and cost as criteria is provided. A reference is made to the screening of technologies table. Subsections for each applicable technology type may be used.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The purpose of this section is to develop a range of alternatives using various combinations of the technologies identified in section 2.3 above and to screen the developed alternatives to determine which will subsequently undergo a more thorough and detailed analysis. This section will be significantly streamlined for focused CMS/FS reports.

3.1 Development of Alternatives

The purpose of this section is to provide a description of the alternatives developed by assembling combinations of technologies and the media to which they apply. A minimum of 3 alternatives will be evaluated unless the USEPA and SCDHEC agree to an OU-specific exception. For example, if a No Action Alternative and a Land Use Control Alternative are under consideration, a third alternative that reduces the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants will also be included. (Reference 40 CFR 300.430(e)(3) for more information). Each alternative will be divided into separate subsections as shown below.

3.1.1 Alternative 1

A description of Alternative 1 is provided.

3.1.2 Alternative [X]

A description of Alternative [X] is provided. A new subsection and description is provided for each alternative developed.

3.2 Screening of Alternatives

The purpose of this section is to evaluate each of the alternatives against the effectiveness, implementability, and cost criteria and to identify the alternatives that subsequently undergo a more thorough and detailed analysis in section 4.0 below.

3.2.1 Alternative 1

An evaluation of how reasonable the use of the alternative will be for the OU with respect to effectiveness, implementability, and cost is provided. A statement is made on whether or not the alternative is retained for further evaluation in the detailed analysis of alternatives.

3.2.2 Alternative [X]

An evaluation of how reasonable the use of the alternative will be for the OU with respect to effectiveness, implementability, and cost is provided. A statement is made on whether or not the alternative is retained for further evaluation in the detailed analysis of alternatives. The evaluation is provided for each alternative developed.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

The purpose of this section is to provide a discussion of the relative strengths and weaknesses of the alternatives retained from the screening analysis in section 3.2 with respect to each of the nine NCP evaluation criteria. The remedial alternatives under consideration are also evaluated with respect to impact injury to the natural resources.

4.1 Individual Analysis of Alternatives

The analysis of the individual alternatives with respect to the specified criteria is presented as a narrative accompanied by a summary table. A detailed analysis of each alternative is provided for each of the following evaluation criteria:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with ARARs (A reference to the table of potential ARARs is included.)

Primary Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost (Include a reference to Appendix A, *Detailed Cost Estimates*)

Modifying Criteria

- Community acceptance
- State acceptance

Primary balancing criteria are factors that identify key tradeoffs among alternatives. Modifying criteria (i.e., State or support agency acceptance, community acceptance) will be considered during final remedy selection.

4.1.1 Assessment of Alternative 1

A narrative discussion of the assessment of Alternative 1 with respect to the threshold and primary balancing criteria is presented. The assessment may be split into subsections for each evaluation criteria.

4.1.2 Assessment of Alternative [X]

A narrative discussion of the assessment of Alternative [X] with respect to the threshold and primary balancing criteria is presented. The assessment may be split into subsections for each evaluation criteria. The evaluation is provided in a new subsection for each alternative developed.

4.2 Comparative Analyses

The purpose of this section is to identify key advantages and disadvantages for each alternative in relation to the evaluation criteria. A table that summarizes the results of the comparative analysis is provided. In addition, the ranking of each alternative with respect to the other alternatives for the evaluation criteria is described and a table that summarizes the results of the comparative ranking analysis is provided.

Alternatives	**Overall Protection of Human Health and the Environment**	**Compliance with ARARs**	**Long-term Effectiveness**	**Reduction of Toxicity, Mobility, and Volume through Treatment**	**Short-term Effectiveness**	**Implementability**	**Cost**	**Overall Ranking**
Alternative 1	Yes/No	Yes/No/NA	1-5	1-5	1-5	1-5	$ xxx	4-20
Alternative X	Yes/No	Yes/No/NA	1-5	1-5	1-5	1-5	$ xxx	4-20

Note: Numeric range 1 through 5, where 1= worst and 5 = best

5.0 REFERENCES

This section provides a list of the documents that are referred to in the CMS/FS and may include the following supporting reference document.[2]

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., October 1988.

Figures and Tables

A sample of the figures and tables that may be included in the CMS/FS are listed below. Figures and tables will be specific for the OU. Figures and tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location of the Operable Unit within the Savannah River Site
Figure 2. Layout of the Operable Unit
Figure 3. Schematic Cross Section of the Operable Unit
Figure 4. Conceptual Site Model
Figure 5. Alternative Illustration /Description

Table 1. Risk Summary - Refined Constituents of Concern for the Operable Unit
Table 2. Preliminary Remedial Goals for the Operable Unit
Table 3. Technology Screening
Table 4. Alternative Screening
Table 5. Summary of the Potential ARARs
Table 6. Comparison of Alternatives to CERCLA Criteria
Table 7. Comparative Analysis of Alternatives

Appendices

A sample list of appendices to be included in the CMS/FS is listed below.

Appendix A. Detailed Cost Estimates

[2] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

COMBINED RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTGATION/ REMEDIAL INVESTIGATION/ BASELINE RISK ASSESSMENT/CORRECTIVE MEASURES STUDY/FEASIBILITY STUDY FORMAT

EXECUTIVE SUMMARY

The Executive Summary briefly summarizes the Combined Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Remedial Investigation (RI)/Baseline Risk Assessment (BRA)/ Corrective Measures Study (CMS)/Feasibility Study (FS) report and will prepare the Core Team for validating key conclusions. The Executive Summary includes a brief description of the operable unit (OU), refined constituents of concern (RCOCs), risk assessment results, problems warranting action, remedial action objectives (RAOs), preliminary remedial goals[1] (PRGs), and remedial alternatives evaluated. The Executive Summary of the RFI/RI/BRA/CMS/FS is consistent with the Problem Identification and Feasibility Study scoping summary for the OU. The RFI and CMS are not included if the OU is Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) only.

1.0 INTRODUCTION

The purpose of following sections is to provide a discussion of the purpose and layout of the document and basic information about the OU.

1.1 Purpose and Organization of Report

This section provides a description of the RFI/RI/BRA/CMS/FS report purpose and organization with a brief description of each section and list of appendices as appropriate.

1.2 Regulatory Background

This section introduces the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) which coordinates remedial activities into one comprehensive strategy that fulfills dual regulatory requirements of RCRA and CERCLA. The status of the OU as a RCRA/CERCLA unit or CERCLA-only unit is identified.

[1] Preliminary remedial goals were formerly known as remedial goal options in earlier SRS regulatory documentation.

1.3 Operable Unit History

This section provides a description of the OU history, location, and setting. This information is available from the OU Work Plan and is updated as necessary. Appropriate figures and tables including location maps, surface feature figures, unit summary tables, etc., are included.

1.4 Land Use

This section provides a description of the current land use for the area occupied by the OU as defined by the SRS Land Use Control Assurance Plan as well as reasonably anticipated future use. This section identifies if groundwater is part of the OU or addressed separately in a groundwater OU. Figures are referenced as needed.

1.5 Natural Resource Trustees

This section provides a brief discussion of the Natural Resource Trustees and their involvement with the project. A table that identifies the SRS Natural Resource Trustees and their responsibilities is included. Potential natural resource injuries that are suspected or known based on the conclusions of this report are documented by completion of the Natural Resource Injury Evaluation Checklist (Appendix G) and are summarized in Section 3.11.

2.0 OPERABLE UNIT DESCRIPTION

The purpose of the following sections is to provide a discussion of the physical attributes of the OU. Historical data and the data results from the OU assessment activities to ascertain physical characteristics as well as investigation activities are presented in the appropriate subsection for which the activity was conducted. (For example, geologic data gathered via cone penetrometer technology and/or coring operations could be utilized to augment the OU-specific Geology subsection). Figures and tables are referenced in each subsection as appropriate.

2.1 Physical Setting

This section provides a brief description of the OU location within the SRS (and the subunit locations within the OU if more than one exists).

2.1.1 Habitats and Ecological Setting

This section provides a description of the environmental setting of the OU that includes a description of vegetative communities, wildlife, threatened and endangered species, etc. Reference is made to a habitat map or any other surveys that may be applicable (e.g., threatened, endangered and sensitive [TES] species surveys, etc.) and/or a table of TES plant/animal species.

2.1.2 Surface Features

This section provides a description of the setting of the OU with respect to surface features (e.g., topography).

2.1.3 Meteorology

This section provides a description of the typical weather conditions for the OU. A reference to existing sources that summarize SRS weather conditions may be used instead of a detailed discussion.

2.2 Geology and Hydrogeology

This section provides a description of the OU geology, hydrogeology, surface water hydrology, and soil types.

2.2.1 Operable Unit-Specific Geology

This section provides a description of the OU-specific geology (i.e., formations). It includes historical data as well as data obtained during the investigation.

2.2.2 Operable Unit-Specific Hydrogeology

This section provides a description of the OU-specific hydrogeology (i.e., aquifers and aquitards). This section includes historical data as well as data obtained during the investigation.

2.2.3 Operable Unit Surface Water Hydrology

This section provides a description of the surface water hydrologic characteristics for the OU including wetlands, streams, etc.

2.2.4 Operable Unit Soils

This section provides a description of the soil characteristics associated with the OU that has been investigated.

2.3 Conceptual Site Model

The purpose of this section is to provide a discussion of the conceptual site model (CSM) for the OU. This includes a discussion of the known and suspected sources of contamination, the types of contaminants and potentially affected media, the known and potential routes of migration, and the known or potential human and ecological receptors (see protocol DG-2, *Exposure Pathways/Conceptual Site Model*). The components which constitute an exposure pathway are discussed in subsections and included in a CSM figure referenced in this Section. Components include:

1. Primary Sources of Contamination – this section contains a brief description of the waste(s) initially disposed of or released within the OU.
2. Primary Sources Environmental Release Mechanisms – this section describes how contaminants from the primary source enter the environment or impact secondary sources.
3. Secondary Sources of Contamination - this section identifies the environmental media contaminated by release of the primary source.
4. Secondary Sources Environmental Release Mechanisms - this section describes the processes that currently, or may in the future, release contaminants for exposure to potential receptors.
5. Exposure Media - this section identifies all media that could potentially be contaminated.
6. Exposure Routes – this section identifies the method of entry into the receptor (e.g., inhalation, ingestion, dermal contact, external radiation).
7. Receptors (Human and Ecological) – this section identifies potential future human receptors (e.g., hypothetical resident, industrial worker) as well as generic descriptions of potential ecological receptors (e.g., terrestrial or aquatic/semi-aquatic).

3.0 REMEDIAL INVESTIGATION

This section describes the collection, assessment, and evaluation of the data that identify the problem(s) warranting action from the investigation.

3.1 Operable Unit Investigation Overview

This section provides an overall discussion of the collection of data. An overview of the sampling and analysis plan(s) which were executed for this OU as part of the RFI/FS program is included.

3.2 Site Characterization and Data Usability

This section provides a detailed description of the OU-specific investigation activities. Information about the number of samples and the type of sampling and analysis conducted to characterize CSM sources and exposure media is included. The information will also be used to describe assessment activities for each subunit within the OU as discussed in the OU-specific scoping summary document. The text will refer to Appendix A, *Investigation Data/Data Summary Tables* and Appendix I, *Data Usability Report* as appropriate.

3.3 Unit-Specific Constituent Screening

This section describes the unit-specific constituent (USC) screening process. USCs are those constituents that are likely present from unit-related activities. The text will refer to the USC Screening Tables in Appendix A (see protocol USC-1, *Unit-Specific Constituents* for the screening steps). Constituents identified as USCs are evaluated in the contaminant fate and transport analysis.

3.4 Contaminant Fate and Transport Analysis

This section provides a brief overview of the contaminant fate and transport analysis, i.e., contaminant migration (CM) analysis. The text will refer to Appendix B, *Contaminant Fate and Transport Analysis* for details.

3.5 Human Health Risk Assessment Methodology

This section provides a brief overview of the human health risk assessment (HHRA) methodology. The text will refer to Appendix C, *Human Health Risk Assessment* for details.

3.6 Ecological Risk Assessment Methodology

This section provides a brief overview of the ecological risk assessment (ERA) methodology. The text will refer to Appendix D, *Ecological Risk Assessment* for details.

3.7 Principal Threat Source Material Evaluation Methodology

This section provides a brief overview of the principal threat source material (PTSM) evaluation. The text will refer to Appendix E, *Principal Threat Source Material Evaluation* for details.

3.8 Operable Unit Subunit

This section provides a more in-depth description of the characterization, data, risk assessment results, contaminant migration results, PTSM results, etc., and is specific to an OU subunit (or exposure area). Multiple subunits or exposure areas may be presented.

3.8.1 Operable Unit Subunit Description

This section provides a more-in-depth description that is specific to this OU subunit, including physical setting, waste composition, and process history.

3.8.2 Operable Unit Subunit Characterization and Data Summary

This section provides an overview of the sampling and analysis plan, which was executed for this OU subunit, including sample location map(s). The text will refer to Appendix A.

3.8.3 Operable Unit Subunit Nature and Extent of Contamination

This section describes the USCs and refers to the screening table in Appendix A. At a minimum, RCOCs (i.e., COCs that likely warrant remedial action) will be illustrated in an appropriate manner. Based on best professional judgment, other constituents/parameters that will aid in the interpretation of the OU subunit in terms of the CSM will also be illustrated, as needed.

3.8.4 Operable Unit Subunit Contaminant Fate and Transport Evaluation Results

This section provides a summary discussion of the major findings from the CM analysis. The text will refer to the presentation and interpretation of the results provided in Appendix B of the document. CM constituents of potential concern (COPCs), COCs and RCOCs are identified as appropriate.

3.8.5 Operable Unit Subunit Human Health Risk Assessment Results

This section presents a summary of the results of the HHRA. The text will refer to the detailed analysis provided in Appendix C of the document. HH COPCs, COCs and RCOCs are identified as appropriate.

3.8.6 Operable Unit Subunit Ecological Risk Assessment Results

This section presents a summary of the results of the ERA. The text will refer to the detailed analysis provided in Appendix D of the document. Constituents of potential ecological concern (COPECs), COPCs, COCs and RCOCs are identified as appropriate.

3.8.7 Operable Unit Subunit Principal Threat Source Material Evaluation Results

This section presents a summary discussion of the major findings from the PTSM analysis. The text will refer to the presentation and interpretation of the results provided in Appendix E of the document. The results of the uncertainty evaluation and a list of the PTSM RCOCs is provided.

3.8.8 Operable Unit Subunit Summary of Problems Warranting Action

This section summarizes the RCOCs for this OU subunit for the CM-, HH-, ECO-, and PTSM-based RCOCs. The problems warranting action statement(s) per the OU-specific scoping summary document are presented in this section.

3.9 Summary of Refined Constituents of Concern and Refined Conceptual Site Model

The RCOCs that warrant remedial action are summarized in this section. The preliminary CSM(s) presented in Section 2 are revised to include only the RCOCs and reviewed to determine if any other modifications are necessary to accurately depict site conditions (see protocol DG-2).

3.10 Applicable or Relevant and Appropriate Requirements Evaluation

This section compares the analytical data to the chemical-specific applicable or relevant and appropriate requirements (ARARs). Typically, this evaluation will include soil limits for polychlorinated biphenyls (PCBs) and lead; maximum contaminant limits (MCLs) and/or ambient water quality standards (AWQS) for surface waters; and MCLs for groundwater (see protocol ARAR-1, *ARAR Constituents of Concern*).

3.11 Natural Resource Injury Evaluation

This section provides a discussion of potential natural resource injuries that are suspected or known. The potential injuries are documented by completion of the checklist provided in Appendix G, *Natural Resource Injury Evaluation Checklist*. Each of the following resources are summarized, as appropriate; surface water, groundwater, air, geological, and biological.

4.0 REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIAL GOALS

The purpose of this section is to provide the problems warranting action, RAOs, and uncertainties by OU subunit as presented in the OU-specific scoping summary document. This section provides documentation on the development of PRGs for the identification of potential cleanup levels. The RCOCs and PRGs will be based on key conclusions determined by the Core Team during the Problem Identification scoping meeting.

4.1 Remedial Action Objectives

The purpose of this section is to present the problem statement(s) by OU subunit as presented in the OU-specific scoping summary document. A statement that addresses the contaminants of interest for the OU will be included in this section. The RAOs are defined specifically for the problem to which they apply. The RAOs will specify the exposure pathway to be mitigated and the receptor to be protected. Key uncertainties specific to the remedial decisions identified for each OU subunit will also be presented. RAOs are typically listed in bullet form.

4.2 Preliminary Remedial Goals Development

This section describes the basis for the development of PRGs. In addition, figures are provided illustrating the locations where each of the PRGs are exceeded at the OU.

4.2.1 Contaminant Migration Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the protection of groundwater, based on the contaminant fate and transport analysis. The text will refer to Appendix F, *Preliminary Remedial Goals for the Operable Unit.*

4.2.2 Human Health Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the protection of human health. The text will refer to Appendix F. These will apply to the various media associated with the OU.

4.2.3 Ecological Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the protection of ecological receptors in the environment. The text will refer to Appendix F. These will apply to the various media associated with the OU.

4.2.4 Principal Threat Source Material Preliminary Remedial Goals

This section provides a discussion of the development of PRGs for the PTSM evaluation. The text will refer to Appendix F.

4.2.5 Applicable or Relevant and Appropriate Requirements Preliminary Remedial Goals

This section provides a discussion of the development of the PRGs for the purpose of compliance with chemical-specific ARARs. The text will refer to Appendix F.

4.3 Most Restrictive and Most Likely Preliminary Remedial Goals

A tabular listing, by media, of the PRGs based on ARARs, contaminant migration, human health risk, ecological risk, and PTSM are provided in this section. A range of background values for each media are included. From this table, the *most restrictive* PRG(s) for each media are determined based on the lowest PRG derived from the ARAR, contaminant migration, human health, ecological, and PTSM PRGs. The *most likely* PRGs will consider the land use and likely response actions as determined by the Core Team and may differ from the most restrictive PRGs. If not already provided in Section 3, figures should be provided illustrating the locations where each of the PRGs are exceeded at the OU.

5.0 CORRECTIVE MEASURES STUDY/FEASIBILITY STUDY

The purpose of this section is to present the development, screening, and detailed analysis of remedial alternatives corresponding to the problem statements in Section 4.1, to support the Core Team in the selection of a remedy for the OU. For evaluation purposes, the OU may be segregated into subunits.

5.1 Identification and Screening of Technologies

The purpose of this section is to provide a description of the general response actions for the OU, identify potential remedial technologies for each general response action, and screen remedial technologies with respect to National Contingency Plan (NCP) criteria: effectiveness, implementability and cost. The initial list of action technologies applicable to the OU is typically based on the approved likely response actions from prior scoping meetings with USDOE, USEPA and SCDHEC, as well as experience with similar response actions.

5.1.1 General Response Actions

The purpose of this section is to describe the OU-specific actions that achieve the RAOs and satisfy the requirements of the NCP for each problem warranting action. General response actions may include treatment, containment, excavation, extraction, disposal, institutional actions, or a combination of these. For each medium of interest, a description of the estimated area or volume where treatment, containment, or exposure technologies may be applied is provided.

5.1.2 Identification and Evaluation of Technology Types and Process Options

A description of the universe of potentially applicable technology types and process options is provided. An evaluation of how reasonable the use of the technologies will be at the OU using the broad categories of effectiveness, implementability, and cost as criteria is provided. A reference is made to the screening of technologies table. Subsections for each applicable technology type may be used.

5.2 Development and Screening of Alternatives

The purpose of this section is to develop a range of alternatives using various combinations of the technologies identified in section 5.1.2 above and to screen the developed alternatives to determine which will subsequently undergo a more thorough and detailed analysis.

5.2.1 Development of Alternatives

The purpose of this section is to provide a description of the alternatives developed by assembling combinations of technologies and the media to which they apply. A minimum of 3 alternatives

must be evaluated unless the USEPA and SCDHEC agree to a unit-specific exception. For example, if a No Action Alternative and a Land Use Control Alternative are under consideration, a third alternative that reduces the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants may also be included. (Reference 40 CFR 300.430(e)(3) for more information). Each alternative will be divided into separate subsections as shown below.

5.2.1.1 Alternative 1

A description of Alternative 1 is provided.

5.2.1.2 Alternative [X]

A description of Alternative [X] is provided. A new subsection and description is provided for each alternative developed.

5.2.2 Screening of Alternatives

The purpose of this section is to evaluate each of the alternatives against the effectiveness, implementability, and cost criteria and to identify the alternatives that subsequently undergo a more thorough and detailed analysis in section 5.3 below.

5.2.2.1 Alternative 1

An evaluation of how reasonable the use of the alternative will be for the OU with respect to effectiveness, implementability, and cost is provided. A statement is made on whether or not the alternative is retained for further evaluation in the detailed analysis of alternatives.

5.2.2.2 Alternative [X]

An evaluation of how reasonable the use of the alternative will be for the OU with respect to effectiveness, implementability, and cost is provided. A statement is made on whether or not the alternative is retained for further evaluation in the detailed analysis of alternatives. The evaluation is provided for each alternative developed.

5.3 Detailed Analysis of Alternatives

The purpose of this section is to provide a discussion of the relative strengths and weaknesses of the alternatives retained from the screening analysis in section 5.2.2 with respect to each of the nine NCP evaluation criteria. The remedial alternatives under consideration are also evaluated with respect to impact injury to the natural resources.

5.3.1 Individual Analysis of Alternatives

The analysis of the individual alternatives with respect to the specified criteria is presented as a narrative accompanied by a summary table. A detailed analysis of each alternative is provided for each of the following evaluation criteria:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with ARARs (A reference to the table of potential ARARs is included.)

Primary Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost (Include a reference to Appendix H, *Detailed Cost Estimates*)

Modifying Criteria

- Community acceptance
- State acceptance

Primary balancing criteria are factors that identify key tradeoffs among alternatives. Modifying criteria (i.e., State or support agency acceptance, community acceptance) will be considered during final remedy selection.

5.3.1.1 Assessment of Alternative 1

A narrative discussion of the assessment of Alternative 1 with respect to the threshold and primary balancing criteria is presented. The assessment may be split into subsections for each evaluation criteria.

5.3.1.2 Assessment of Alternative [X]

A narrative discussion of the assessment of Alternative [X] with respect to the threshold and primary balancing criteria is presented. The assessment may be split into subsections for each evaluation criteria. The evaluation is provided in a new subsection for each alternative developed.

5.4 Comparative Analysis

The purpose of this section is to identify key advantages and disadvantages for each alternative in relation to the evaluation criteria. A table that summarizes the results of the comparative analysis is provided. In addition, the ranking of each alternative with respect to the other alternatives for the evaluation criteria is described and a table that summarizes the results of the comparative ranking analysis is provided.

Alternatives	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-term Effectiveness	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-term Effectiveness	Implementability	Cost	Overall Ranking
Alternative 1	Yes/No	Yes/No/NA	1-5	1-5	1-5	1-5	$ xxx	4-20
Alternative X	Yes/No	Yes/No/NA	1-5	1-5	1-5	1-5	$ xxx	4-20

Note: Numeric range 1 through 5, where 1= worst and 5 = best

6.0 SUMMARY/CONCLUSION

The purpose of this section is to provide a final succinct conclusion representative of key decisions agreed to by the Core Team during the Problem Identification and Feasibility Study scoping meeting(s). The conclusion section will summarize the problems warranting action, RAOs, remedial alternatives evaluated, and uncertainties by OU subunit as presented in the OU-specific scoping summary document. The intent of this section is to summarize the conclusions of the OU-specific scoping summary document in support of the OU strategy.

6.1 Operable Unit Subunit

6.1.1 Problem Warranting Action

This section presents the problem statement(s) by OU subunit as presented in the OU-specific scoping summary document.

6.1.2 Remedial Action Objective(s)

This section presents the RAO(s) defined specifically for the problem to which they apply. The RAO(s) will be presented by OU subunit and specify the exposure pathway to be mitigated and the receptor to be protected.

6.1.3 Remedial Alternatives Evaluated

This section presents the remedial alternatives that were considered in the CMS/FS.

6.2 Operable Unit Strategy

This section identifies the key management strategies related to achieving overall OU remediation. Key components of the strategy warranting discussion may include the identification of early actions, integration with other OUs, segregation of OU components, and modifications to project schedules and milestones based on changes in technical understanding.

7.0 IMPLEMENTATION SCHEDULE

A summary of the key deliverables and submittal dates for the OU as identified in the FFA are provided in this section. Deliverables typically include the RFI/RI/BRA/CMS/FS Rev. 0; Statement of Basis/Proposed Plan, Rev. 0; Record of Decision, Rev. 0; Issuance of the ROD;

Corrective Measures Implementation Report/Remedial Action Completion Report, Rev. 0; Land Use Controls Implementation Plan, Rev. 0; and Remedial Action Start date.

8.0 REFERENCES

This section provides a list of the documents that are referred to in the RFI/RI/BRA/CMS/FS and may include the following reference documents.[2]

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final, OSWER Directive 9355.3-01, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., October 1988.

Risk Assessment Guidance For Superfund, Volume 1, Human Health Evaluation Manual (Part A), Interim Final, EPA 540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C., December 1989.

Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final, OSWER Directive 9285.7-25, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., June 1997.

Guidelines for Ecological Risk Assessment. Risk Assessment Forum, EPA/630/R-95/002F, U.S. Environmental Protection Agency, Washington, D.C., April 1998.

Region 4 Ecological Risk Assessment Supplemental Guidance to ERAGS, Scientific Support Section, Superfund Division, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, March 2018.

Region 4 Human Health Risk Assessment Supplemental Guidance, Scientific Support Section, Superfund Division, U.S. Environmental Protection Agency, Region 4, Atlanta, GA, March 2018.

Figures and Tables

A sample of the figures and tables that may be included in the RFI/RI/BRA/CMS/FS are listed below. Figures and tables will be specific for the OU.

Figure 1. Operable Unit Location Map
Figure 2. Operable Unit Photograph
Figure 3. Comprehensive Site Features
Figure 4. Surface Topography

[2] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

Figure 5. Surface Water Hydrology
Figure 6. Soil Types
Figure 7. Surface Geology
Figure 8. Lithostratigraphic and Hydrostratigraphic Unit Comparisons
Figure 9. Groundwater Potentiometric Surface and Flow Direction Map
Figure 10. Preliminary Conceptual Site Model
Figure 11. Operable Unit Sample Locations
Figure 12. Operable Unit Threshold (e.g., PRG/RSL/MCL/AWQC) Exceedance Locations
Figure 13. Refined Conceptual Site Model
Figure 14. Alternative Illustration/Description

Table 1. Savannah River Site Natural Resource Trustees and Their Responsibilities
Table 2. TES Plant/Animal Species Known to Occur on SRS
Table 3. Average Temperature and Precipitation for SRS
Table 4. Preliminary Remedial Goals for the Operable Unit
Table 5. Alternative Screening
Table 6. Summary of Potential ARARs
Table 7. Comparison of Alternatives to the CERCLA Criteria
Table 8. Comparative Analysis of Alternatives

List of Appendices

A sample of the appendices that may be included in the RFI/RI/BRA are listed below.

Appendix A. Investigation Data/Data Summary Tables
Appendix B. Contaminant Fate and Transport Analysis
Appendix C. Human Health Risk Assessment
Appendix D. Ecological Risk Assessment
Appendix E. Principal Threat Source Material Evaluation
Appendix F. Preliminary Remedial Goals for the Operable Unit
Appendix G. Natural Resource Injury Evaluation Checklist
Appendix H. Detailed Cost Estimates
Appendix I. Data Usability Report

APPENDIX A. INVESTIGATION DATA/DATA SUMMARY TABLES FORMAT

The purpose of this appendix is to provide the data used in the contaminant migration analysis, risk assessment and PTSM evaluation. If applicable, the text will refer to the electronic file that contains all of the OU characterization data in an electronic format. Data summary tables are provided for each OU subunit as applicable.

A.1 DATA SUMMARY TABLES

A.2 OPERABLE UNIT SUBUNIT 1

A.2.1 Soil Media

A.2.1.1 Surface Interval (0-1 ft interval)

(see sample Data Summary Table A-1)

A.2.1.2 Subsurface Interval (1-4 ft interval)

(see sample Data Summary Table A-1)

A.2.1.3 All Depths

(95% Upper Confidence Level on the Mean Concentration [UCL] and Reasonable Maximum Exposure [RME] columns not required)

A.2.1.4 Unit-Specific Constituent Screening Table (all depths)

(see sample USC Screening Table A-2)

A.3 OPERABLE UNIT SUBUNIT 2 (AS NEEDED)

A.3.1 Sediment Media

A.3.1.1 Surface Interval (0-1 ft interval)

(see sample Data Summary Table A-1)

A.3.1.2 All Depths

(95% UCL and RME columns not required)

A.3.1.3 Unit-Specific Constituent Screening Table (all depths)

(see sample USC Screening Table A-2)

A.3.2 Surface Water Media

A.3.2.1 Unfiltered Samples

(see sample Data Summary Table A-1)

A.3.2.2 Filtered Samples

(see sample Data Summary Table A-1)

Table A-1. SAMPLE Data Summary Table

Analyte	Units	Samples	Non-Detects	Detects	J-Detects	Distribution Code	UCL Method	Mean	95% UCL	Max	Min	RME	Max Location	Qualifier of Max	Max Date
ACETONE	mg/kg	37	25	12	8	L	3	0.004	0.00452	0.0542	ND	0.00452	FBFA-25	--	8/22/2019
ALUMINUM	mg/kg	38	0	38	3	N	1	7127.3	8105	16700	2440	8105	FBFA-13	--	7/15/2019
ANTIMONY	mg/kg	38	35	3	3	X	7	0.2002	0.353	0.541	ND	0.353	FBFA-34	J	7/24/2019
AROCLOR 1254	mg/kg	37	29	8	3	G	2	0.0065	0.0198	0.119	ND	0.0198	FBFA-19	--	7/17/2019
AROCLOR 1260	mg/kg	37	23	8	9	G	2	0.005	0.0122	0.0713	ND	0.0122	FBFA-19	--	7/17/2019
ARSENIC	mg/kg	38	0	19	19	G	2	3.68	4.526	14.5	0.586	4.526	FBFA-11	--	7/15/2019
BARIUM	mg/kg	38	0	38	1	N	1	14.25	17.07	40.7	1.24	17.07	FBFA-4	--	7/10/2019
BENZO[A]PYRENE	mg/kg	36	34	2	2	X	7	0.0076	0.0159	0.0614	ND	0.0159	FBFA-28	J	8/22/2019
BENZO[B]FLUORANTHENE	mg/kg	36	31	5	5	X	7	0.0118	0.0245	0.163	ND	0.0245	FBFA-28	J	8/22/2019
BERYLLIUM	mg/kg	38	6	32	28	X	4	0.3166	0.848	4.55	ND	0.848	FBFA-21	--	7/17/2019
CADMIUM	mg/kg	38	33	5	4	G	2	0.0963	0.196	1.03	ND	0.196	FBFA-20	--	7/17/2019
CALCIUM	mg/kg	38	0	38	5	L	3	612.7	855.4	5150	50.2	855.4	FBFA-21	--	7/17/2019
CARBAZOLE	mg/kg	36	35	1	1	--	--	0.0057	--	0.0173	ND	0.0173	FBFA-15	J	7/16/2019
CHROMIUM	mg/kg	38	0	38	3	L	3	20.61	24.79	230	3.05	24.79	FBFA-11	--	7/15/2019
CHRYSENE	mg/kg	36	34	2	2	X	7	0.0112	0.0254	0.114	ND	0.0254	FBFA-15	J	7/16/2019
COBALT	mg/kg	38	2	36	15	G	2	0.896	1.204	3.72	ND	1.204	FBFA-21	--	7/17/2019
COPPER	mg/kg	38	0	38	13	L	3	4.672	5.801	27.1	0.629	5.801	FBFA-15	--	7/16/2019
IRON	mg/kg	38	0	38	2	G	2	13341.6	16068	47200	2640	16068	FBFA-11	--	7/15/2019
LEAD	mg/kg	38	0	38	4	G	2	6.801	8.275	21.7	1.59	8.275	FBFA-20	--	7/17/2019
MAGNESIUM	mg/kg	38	0	38	3	X	4	294.8	702.1	2880	702.1	702.1	FABF-21	--	7/17/2019
MANGANESE	mg/kg	38	0	38	2	L	3	67.996	131.9	540	2.92	131.9	FABF-21	--	7/17/2019
MERCURY	mg/kg	37	2	35	12	X	4	0.0221	0.0387	0.144	ND	0.0387	FBFA-19	--	7/17/2019
NICKEL	mg/kg	38	0	38	3	G	2	2.117	2.589	8.17	0.463	2.589	FBFA-37	--	7/22/2019
POTASSIUM	mg/kg	38	0	38	1	X	4	155.3	302.8	1030	37.3	302.8	FBFA-21	--	7/17/2019
SELENIUM	mg/kg	38	31	7	4	X	7	0.9317	1.747	9.05	ND	1.747	FBFA-26	--	8/22/2019
SILVER	mg/kg	38	35	3	1	X	7	0.0904	0.177	0.743	ND	0.177	FBFA-3	--	7/11/2019
SODIUM	mg/kg	38	27	11	10	G	2	7.643	12.62	42	ND	12.62	FBFA-21	--	7/17/2019
TETRACHLOROETHYLENE (PCE)	mg/kg	37	36	1	1	--	--	0.0002	--	0.318	ND	0.0004	FBFA-15	J	7/16/2019
THALLIUM	mg/kg	38	34	4	0	X	7	1.817	3.78	23.6	ND	3.78	FBFA-26	--	8/22/2019
VANADIUM	mg/kg	38	0	38	0	G	2	39.46	49.29	187	7.17	49.29	FBFA-11	--	7/15/2019
ZINC	mg/kg	38	0	38	21	X	4	48.23	117.2	426	1.18	117.2	FBFA-20	--	7/172019
Radionuclides															
CESIUM-137	pCi/g	6	1	5	5	X	7	0.102	0.139	0.153	0.0594	0.139	FBFA-3	J	7/11/2019
COBALT-60	pCi/g	7	6	1	0	--	--	0.0375	--	0.545	ND	0.545	FBFA-21	--	7/17/2019
POTASSIUM-40	pCi/g	7	0	7	4	X	8	5.436	56.16	24.8	1.07	24.8	FBFA-21	--	7/17/2019
THORIUM-232	pCi/g	4	0	4	3	N	1	1.172	1.579	1.64	0.806	1.579	FBFA-5	--	7/11/2019
URANIUM-238	pCi/g	4	0	4	1	N	1	1.068	1.588	1.67	0.619	1.588	FBFA-21	--	7/17/2019

Distribution Code:
- N Normal Distribution
- L Lognormal Distribution
- G Gamma Distribution
- X Non-Parametric

ND = Non-Detect

UCL Method Code:
(as determined by ProUCL)
- 1 Student's t UCL
- 2 Approximate Gamma UCL
- 3 95% H-UCL
- 4 95% Chebyshev UCL
- 5 97.5% Chebysev UCL
- 6 99% Chebyshev UCL
- 7 Kaplan-Meier (KM) t UCL
- 8 Hall's Bootstrap UCL

Table A-2. SAMPLE Unit-Specific Screening Table (all depths)

ANALYTE	UNITS	Max[1] Result	Max Qualifier	Max Location	TOP DEPTH (ft)	BOTTOM DEPTH (ft)	SRS 2X Mean Background[2]	Is Max Detect > 2X SRS Mean Bkg?[3]
Inorganics								
ALUMINUM	mg/kg	35700.0		FBFA-17	28	30	13395	Yes
ANTIMONY	mg/kg	2.40	J	FBFA-7	1	4	2.653	No
ARSENIC	mg/kg	14.50		FBFA-11	0	1	4.453	Yes
BARIUM	mg/kg	62.10		FBFA-4	1	4	33.108	Yes
BERYLLIUM	mg/kg	4.550		FBFA-21	0	1	0.305	Yes
CADMIUM	mg/kg	1.030		FBFA-20	0	1	0.444	Yes
CALCIUM	mg/kg	5150.0		FBFA-21	0	1	334	Yes
CHROMIUM	mg/kg	230.0		FBFA-11	0	1	22.868	Yes
COBALT	mg/kg	9.450		FBFA-17	28	30	1.396	Yes
COPPER	mg/kg	468.0		FBFA-37	1	4	6.352	Yes
IRON	mg/kg	47200.0		FBFA-11	0	1	22001	Yes
LEAD	mg/kg	21.70		FBFA-20	0	1	10.825	Yes
MAGNESIUM	mg/kg	2880.0		FBFA-21	0	1	245.69	Yes
MANGANESE	mg/kg	540.0		FBFA-21	0	1	63.277	Yes
MERCURY	mg/kg	0.1440		FBFA-19	0	1	0.067	Yes
NICKEL	mg/kg	17.20		FBFA-17	28	30	4.154	Yes
POTASSIUM	mg/kg	2170.0		FBFA-17	28	30	213.034	Yes
SELENIUM	mg/kg	26.20		FBFA-38	8	10	3.706	Yes
SILVER	mg/kg	0.7430		FBFA-3	0	1	0.637	Yes
SODIUM	mg/kg	42.0	J	FBFA-17	28	30	43.555	No
THALLIUM	mg/kg	55.10		FBFA-38	8	10	2.936	Yes
VANADIUM	mg/kg	187.0		FBFA-11	0	1	58.060	Yes
ZINC	mg/kg	426.0		FBFA-20	0	1	7.440	Yes
Polychlorinated Biphenyls (PCBs)								
AROCLOR 1254	mg/kg	0.1190		FBFA-19	0	1	N/A	Yes
AROCLOR 1260	mg/kg	0.07130		FBFA-19	0	1	N/A	Yes
Volatile Organic Compounds								
ACETONE	mg/kg	0.08530		FBFA-26	1	4	N/A	Yes
TETRACHLOROETHYLENE (PCE)	mg/kg	0.000720	J	FBFA-18	1	4	N/A	Yes
TRICHLOROETHYLENE (TCE)	mg/kg	0.001450		FBFA-17	28	30	N/A	Yes
Semi-Volatile Organic Compounds								
BENZO[A]PYRENE	mg/kg	0.06140	J	FBFA-28	0	1	N/A	Yes
BENZO[B]FLUORANTHENE	mg/kg	0.16300	J	FBFA-28	0	1	N/A	Yes
CARBAZOLE	mg/kg	0.01730	J	FBFA-15	0	1	N/A	Yes
Radionuclides								
CESIUM-137	pCi/g	0.1530	J	FBFA-3	0	1	0.093	Yes
COBALT-60	pCi/g	0.5450		FBFA-21	0	1	N/A	Yes
POTASSIUM-40	pCi/g	24.80		FBFA-21	0	1	2.519	Yes
THORIUM-232	pCi/g	3.970		FBFA-7	28	30	2.085	Yes
URANIUM-238	pCi/g	2.570		FBFA-7	28	30	1.009	Yes
Table Notes:								
J = estimated value.								
NA = not available.								
1 = Max = maximum detected concentration from all depth intervals.								
2 = *Background Soils Statistical Summary Report for the Savannah River Site* , ERD-EN-2005-0223, Appendix B-2 (All Depth Intervals).								
3 = Constituents identified as an USC if maximum detected concentration is greater than 2X SRS Mean Concentration.								

APPENDIX B. CONTAMINANT FATE AND TRANSPORT ANALYSIS FORMAT

The purpose of this appendix is to provide a discussion of the contaminant fate and transport analysis of the operable unit (OU). The analysis of the contaminant migration (CM) through the soil to underlying groundwater is described in detail. For OU contaminants predicted to exceed the maximum contaminant levels (MCLs) in groundwater by overly conservative CM calculations, detailed groundwater modeling may be appropriate. If groundwater modeling is performed, a summary discussion of the groundwater modeling is provided in this appendix. Results of the CM analysis will be discussed with the Core Team at the Problem Identification Scoping Meeting.

B.1 INTRODUCTION

This section describes the types of CM analyses performed and the rationale for providing those analyses. Soil unit-specific constituents (USCs) identified in Section 3 are analyzed using the CM analysis protocols (Module 5) for their potential to contaminate underlying groundwater and pose a threat to human health or the environment. Typically, the fate and transport analysis is performed using the spreadsheet Vadose Zone Contaminant Migration Multi-Layered (VZCOMML©) modeling program, which accounts for decay processes, infiltration rate, soil properties, vadose zone thickness and chemical behavior.

B.2 CONTAMINANT MIGRATION MODEL

B.2.1 Background

The OU description provided in Section 1.3 and the data discussion provided in Section 3.2 is summarized. The text refers to information in Appendix A, *Investigation Data/ Data Summary Tables*.

B.2.2 Screening Methods

This section describes screening methods for identifying CM constituents of potential concern (COPCs) and CM constituents of concern (COCs) using the VZCOMML© modeling program (see protocols CM-1, *CM Model (VZCOMML)* and CM-2, *CM Constituents of Concern*).

B.2.3 Soil Screening Equations

This section describes the equations used by the VZCOMML© modeling program for the soil screening process. A conceptual framework of the model, the vadose zone, and screening parameters is provided in a figure. Equations for dilution attenuation factor, soil screening limits, mean travel time, saturation concentration and groundwater concentration are provided.

B.2.4 Modeling Parameters

This section presents the steps for performing the CM simulations facilitated by the VZCOMML© modeling program and provides a discussion and the rationale for the selection of vadose zone layers, chemical parameters, and physical parameters for each OU subunit.

B.2.5 Results of Tier I and Tier II Analyses

This section describes the results of the Tier I (CM COPCs) and Tier II (CM COCs) screening for each OU subunit. Rationale for modification to VZCOMML© modeling program inputs throughout the screening simulations is provided. Summary tables of the Tier I and Tier II results are provided as appropriate.

B.2.6 Uncertainty Discussion

This section provides an uncertainty evaluation for COCs per the *Constituents of Concern (COC) Refinement Process Protocol* (COC-1) to determine the final CM RCOCs. The text will refer to the tables from Step B.2.5 as appropriate. A discussion of the uncertainty inherently associated with the CM analysis is included as appropriate.

B.2.7 Supplemental Modeling (if needed)

An additional, more robust fate and transport model (e.g., GoldSim) may be used to further evaluate transport of certain constituents. Rationale for performing supplemental modeling is provided. The supplemental model, inputs, and results are described in this section.

B.3 SUMMARY/CONCLUSIONS OF THE CONTAMINANT MIGRATION ANALYSIS

This section provides the overall summary of the CM analysis by OU subunit, as appropriate. The final CM RCOCs are identified and reference is made to the refined conceptual site model presented in Section 3.

B.4 REFERENCES

This section provides a list of references that are cited in the CM analysis.

Figures and Tables

A sample list of figures and tables to be included in the CM analysis is provided below.

Figure B-1. OU Sample Location Map
Figure B-2. VZCOMML© Contaminant Migration Conceptual Diagram

Table B-1. Chemical Parameters Used for Screening
Table B-2. Vadose Zone Layers
Table B-3. Physical Parameters Used for Screening
Table B-4. Tier I Screening Results
Table B-5. Tier II Simulation Results
Table B-6. Summary Table of Tier I and Tier II Results

This page is intentionally left blank.

APPENDIX C. HUMAN HEALTH RISK ASSESSMENT FORMAT

The purpose of this appendix is to provide documentation of the analysis of the potential for adverse human health effects associated with exposure to unit-related contaminants likely to be present at the operable unit (OU). Baseline human health (HH) risks are those risks to HH that can be anticipated in the absence of any remedial efforts or institutional controls for the unit. Exposure groups and receptors evaluated will be consistent with the key decisions agreed to by the Core Team at the Post Characterization Scoping Meeting prior to the implementation of RFI/RI/BRA protocols. Results of the human health risk assessment (HHRA) will be presented to the Core Team at the Problem Identification Scoping Meeting.

C.1 INTRODUCTION

This section provides a brief explanation of the purpose of the BRA and discusses the organization of the HHRA appendix. Typically, a streamlined approach that considers standard receptors/ exposure assumptions is used for this evaluation.

C.1.1 Background

This section summarizes the OU description provided in Section 1.3.

C.1.2 Data

This section summarizes the data discussion provided in Section 3.2 and refers to information in Appendix A, *Investigation Data/Data Summary Tables*.

C.1.3 Receptors and Exposure Scenarios

This section provides a description of the receptors and exposure scenarios evaluated in the HHRA (see protocol HH-2*, Human Health Receptors and Scenarios* and protocol HH-3, *Human Health Reasonable Maximum Exposure Parameters*).

C.1.4 Sources of Risk-Based Threshold Values

This section provides a description of the sources of the HH risk-based threshold values, i.e., United States Environmental Protection Agency (USEPA) regional screening levels (RSLs), preliminary remediation goals (PRGs), preliminary remediation goals for outdoor surfaces (SPRGs), and preliminary remediation goals for buildings (BPRGs) websites as appropriate. The

USEPA tables and calculator function inputs/ outputs are provided as attachments to this appendix, including tables for any unit-specific receptors (see protocol HH-1, *Sources of Human Health Screening Values*).

C.2 HUMAN HEALTH RISK ASSESSMENT PROCESS

The purpose of this section is to describe the methodology used to identify HH constituents of potential concern (COPCs), constituents of concern (COCs) and refined constituents of concern (RCOCs) for the media of concern (soil, sediment, concrete, surface water, groundwater, etc.).

C.2.1 Soil, Sediment, or Concrete Media

C.2.1.1 Constituents of Potential Concern Screening

The process to identify HH COPCs is summarized in this section. A COPC screening table is provided (see protocol HH-4, *Human Health Constituents of Potential Concern*).

C.2.1.2 Risk/Hazard Calculation

The process to identify HH COCs is summarized in this section. A risk/hazard calculation is typically provided for the resident and industrial worker exposure scenarios (additional receptors as appropriate). A Risk/Hazard Calculation table is provided (see protocol HH-5, *Human Health Constituents of Concern*).

C.2.2 Groundwater or Surface Water Media

C.2.2.1 Comparison to MCL or RSL/PRG or AWQC

The process to screen surface water or groundwater media is described in this section. A formal risk calculation is not presented, rather a comparison to maximum contaminant levels (MCLs), RSLs/PRGs, or AWQCs is provided. For groundwater, the maximum detected concentrations of each constituent are compared to drinking water MCLs. In the absence of an MCL, the tap water RSLs/PRGs is used as a screening threshold.

For surface water, the maximum detected concentrations of each constituent is compared to the drinking water MCLs and ambient water quality criteria (AWQC, Consumption of Water plus Organism). In the absence of an MCL or AWQC, the tap water RSL/PRG is used as a screening

threshold. A comparison table to the screening criteria is provided (see protocol HH-4, *Human Health Constituents of Potential Concern*).

C.2.3 Results/Refinement of Constituents of Concern

This section presents the uncertainty evaluation for COCs per the *Constituents of Concern (COC) Refinement Process Protocol* (COC-1). Discussion is provided for each OU subunit. The text will refer to tables from Steps C.2.1 and C.2.2 as appropriate. A weight of evidence evaluation for any additional considerations (e.g., radioactive decay [recalculate risk for drivers], consideration of other background data, SRS Background for soil, filtered vs. unfiltered water samples, average concentration vs. maximum concentration for surface water, etc.) is included. A recommendation on whether a constituent is a problem warranting action (i.e., identified as an RCOC) for each media type is provided.

C.3 SUMMARY CONCLUSION OF THE HUMAN HEALTH RISK ASSESSMENT

This section is an overall summary of the HHRA results by OU subunit. RCOCs and corresponding risk/hazard levels for each receptor evaluated are identified. The text will refer to the refined conceptual site model presented in Section 3.

C.4 REFERENCES

This section provides a list of the references that are cited in the HHRA.

Figures and Tables

A sample list of figures and tables to be included in the HHRA is provided below.

Figure C-1. Operable Unit Sample Location Map

Table C-1. Human Health COPC Screening for OU Subunit
Table C-2. Human Health Risk/Hazard Calculation for OU Subunit

List of Attachments

A sample list of attachments to be included in the HHRA is provided below.

Attachment C-1: USEPA Regional Screening Levels Table: RSLs for Default Resident and Default Industrial Worker Scenarios *(website accessed date)*

Attachment C-2: USEPA Radionuclide Preliminary Remedial Goals for Superfund Website: Site-Specific PRGs for Residential Scenario *(website accessed date)*

Attachment C-3: USEPA Radionuclide Preliminary Remedial Goals for Superfund Website: Default PRGs for Industrial Worker Scenario *(website accessed date)*

Attachment C-4: MCLs/ AWQC/RSLs for Surface Water Data Screening of Nonradiological Constituents

Attachment C-5: MCLs/PRGs for Surface Water Data Screening of Radiological Constituents

APPENDIX D. ECOLOGICAL RISK ASSESSMENT FORMAT

The purpose of this appendix is to provide documentation of the analysis of the potential for adverse ecological effects associated with exposure to unit-related contaminants likely to be present at the operable unit (OU). The ecological risk assessment (ERA) consists of steps designed to provide a scientifically based and defensible evaluation of exposure and hazard to ecological resources that will support a risk management decision regarding site remediation. Ecological (ECO) risk is associated with the potential for harmful effects to ecological systems resulting from exposure to an environmental stressor. A stressor is any physical, chemical, or biological entity that induces an environmental response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact. Exposure groups and receptors evaluated will be consistent with the key decisions agreed to by the Core Team at the Post Characterization Scoping Meeting prior to the implementation of RFI/RI/BRA protocols. Results of the ERA will be presented to the Core Team at the Problem Identification scoping meeting.

The first step in the process involves a qualitative evaluation regarding the potential for ECO impacts by performing a unit reconnaissance. If a survey of the area concludes that the physical setting of the OU does not provide adequate habitat for community level impacts to wildlife receptors since it is located in an industrial setting or it is very small in size, then further ecological evaluation is not warranted.

D.1 INTRODUCTION

This section provides a brief explanation of the purpose of the BRA and discusses the organization of the ERA appendix.

D.1.1 Background

This section summarizes the OU description provided in Section 1.3.

D.1.2 Data

This section summarizes the data discussion provided in Section 3.2 and refers to information in Appendix A, *Investigation Data/Data Summary Tables*.

D.1.3 Habitats/Receptors/Preliminary Assessment and Measurement Endpoints

This section provides a summary description of the environmental setting of the OU provided in Section 2.1.1 that includes a description of vegetative communities, wildlife receptors, threatened, endangered and sensitive (TES) species, etc. Preliminary assessment and measurement endpoints are discussed (see protocol ECO-2, *Ecological Receptors and Measurement/Assessment Endpoints*).

D.1.4 Sources of Literature-Based Threshold Values

Thresholds to be used in the OU data screening steps will be based on several sources as indicated in protocol ECO-1, *Sources of Ecological Screening and Refinement Values.* A master table that compares the values from each of the sources and identifies the value to be used in the data screening effort is presented. A *Derivation of Screening and Refinement Values* table is included as an attachment.

D.2 ECOLOGICAL RISK ASSESSMENT PROCESS

The purpose of this section is to describe the methodology used to identify constituents of potential ecological concern (COPECs), constituents of potential concern (COPCs), constituents of concern (COCs), and refined constituents of concern (RCOCs) for the media of concern (i.e., soil, sediment, and/or surface water).

D.2.1 Screening-Level Effects Evaluation

The screening-level effects evaluation identifies the potential for adverse ecological effects based on conservative assumptions. The process to identify COPECs is summarized in this section. No observable adverse effects level (NOAEL)-based ecological screening values (ESVs) are used as screening-level effects thresholds to calculate a hazard quotient (HQ) using the maximum detected concentration (see protocol ECO-3, *Constituents of Potential Ecological Concern*).

D.2.1.1 Soil, Sediment or Surface Water Media

The process to identify COPECs for each OU media type is summarized in this section. A COPEC screening table is provided (see protocol ECO-3*).*

D.2.2 Refinement-Level Risk (Hazard) Calculation

The refinement-level risk calculation further focuses on the potential for adverse ecological effects based on less conservative exposure assumptions. The process to identify ECO COPCs is summarized in this section. Lowest observable adverse effects level (LOAEL)- based refinement screening values (RSVs) are used as refinement-level effects thresholds to calculate a HQ using the 95% upper confidence level on the mean concentration (95%UCL) (see protocol ECO-4, *Ecological Constituents of Potential Concern/Constituents of Concern*).

D.2.2.1 Soil, Sediment or Surface Water Media

The process to identify ECO COPCs for each OU media type is summarized in this section. A Refinement-Level Evaluation table is provided (see protocol ECO-4). If additional site-specific data/studies are not warranted, then the COPC analytes are identified as COCs and carried forward to the uncertainty discussion.

D.2.3 Results/Refinement of Constituents of Potential Concern

This section provides an uncertainty evaluation (i.e., weight of evidence) for COPCs/COCs per the *Constituents of Concern (COC) Refinement Process Protocol* (COC-1). Discussion is provided for each OU subunit. The text will refer to tables from Steps D.2.1 and D.2.2 as appropriate. HQ calculations for all receptors that pertain to the RSV exceedance from Section D.2.2 are provided. HQs are adjusted based on population area use factors (PAUF) and mean concentration, if appropriate, and the adjusted HQ calculation is included as an attachment. A weight of evidence evaluation for additional considerations (e.g., other background data, SRS Background for soil, radioactive decay [recalculate risk], unfiltered vs. filtered water samples, etc.) is included as appropriate. A recommendation whether the constituent is a potential problem warranting action for each media type, and/or data gaps that need to be addressed through site-specific biological sampling is provided in this section. If additional ecological/biological studies are not warranted, then the COCs that have been retained in the refinement process are identified as RCOCs.

D.2.4 Screening and Refinement Level Ecological Effects Conclusion

This section summarizes the COPCs/COCs and habitats and environmental media of concern, receptors of concern, exposure pathways, assessment endpoints and risk questions to be addressed

by biological sampling. A determination is made if site-specific ecological studies or other biological data may be needed to address uncertainty associated with using literature-based values only at this stage of the ERA process and whether or not a remedial decision can be made from an ecological risk perspective. If additional studies are not warranted, then the process is complete.

D.2.5 Site-Specific Biological Sampling (if needed)

If deemed appropriate, this section outlines the ECO studies that address the COPCs. This may include further soil/sediment/surface water sampling, trophic modeling, bioaccumulation/ tissue residue studies, toxicity testing, and/or population or community evaluations are the methodologies most commonly used (see protocol ECO-5, *Ecological Site-Specific Data/Studies*).

D.2.6 Additional Risk Information and Uncertainty Evaluation (if needed)

This section discusses the results of the site-specific biological sampling effort and identifies constituents that exceed thresholds as COCs. An additional uncertainty evaluation of the COCs results in the identification of RCOCs as problems warranting remedial action.

D.3 SUMMARY/CONCLUSIONS OF THE ECOLOGICAL RISK ASSESSMENT

This section is an overall summary of the ERA results by OU subunit. RCOCs and corresponding HQs for ecological niches/receptors of concern are identified. The text will refer to the refined conceptual site model presented in Section 3.

D.4 REFERENCES

This section provides a list of references that are cited in the ERA.

Figures and Tables

A sample list of figures and tables to be included in the ERA is provided below.

Figure D-1. Operable Unit Sample Location Map

Table D-1. Screening Level Evaluation for OU Subunit
Table D-2. Refinement Level Evaluation for OU Subunit

List of Attachments

A sample list of attachments to be included in the ERA is provided below.

Attachment D-1: Derivation of Operable Unit Ecological Screening Values (ESVs) and Refinement Screening Values (RSVs)

Attachment D-2: EPA Region 4 Screening Tables for Soil, Sediment, and Surface Water

Attachment D-3: Los Alamos National Laboratory ECORISK Database table of No Effects Ecological Screening Levels and Low Effects Ecological Screening Levels

Attachment D-4: South Carolina Department of Health and Environmental Control, R.61-68, Water Classifications and Standards, table for protection of freshwater aquatic life

Attachment D-5: Uncertainty Tables/PAUF-Adjusted Hazard Quotients

Attachment D-6: Site-Specific Biological Sampling Information (as needed)

- TES Survey Report
- Trophic-Level Modeling Report
- Toxicity Test Results
- Community Surveys
- Other pertinent studies, etc. (e.g., Savannah River Ecology Laboratory)

This page is intentionally left blank.

APPENDIX E. PRINCIPAL THREAT SOURCE MATERIAL EVALUATION FORMAT

The purpose of this appendix is to provide documentation of the principal threat source material (PTSM) evaluation. Exposure groups and receptors evaluated will be consistent with the key decisions agreed to by the Core Team at the Post Characterization Scoping Meeting prior to the implementation of RFI/RI/BRA protocols. Results of the PTSM evaluation will be presented to the Core Team at the Problem Identification scoping meeting.

E.1 INTRODUCTION

This section provides a brief explanation of the concept and determination of principal threat waste as developed by United States Environmental Protection Agency (USEPA) and implemented at the Savanah River Site.

E.1.1 Background

This section summarizes the unit description provided in Section 1.3.

E.1.2 Data

This section summarizes the data discussion provided in Section 3.2 and refers to information in Appendix A, *Investigation Data/Data Summary Tables*.

E.1.3 Receptor

This section provides a description of the receptor evaluated in the PTSM evaluation (see protocol HH-7, *Evaluation of Principal Threat Source Material [PTSM] at SRS Waste Units*).

E.1.4 Sources of Risk-Based Threshold Values

This section provides a description of the sources of the risk-based threshold values, i.e., USEPA regional screening levels (RSLs), preliminary remediation goals (PRGs), preliminary remediation goals for outdoor surfaces (SPRGs), and preliminary remediation goals for buildings (BPRGs) websites as appropriate. A copy of the USEPA tables/ calculator function inputs and outputs as attachments to this appendix, including tables for any unit-specific receptors is provided (see protocol HH-1, *Sources of Human Health Screening Values*).

E.2 PRINCIPAL THREAT SOURCE MATERIAL EVALUATION PROCESS

The process to identify PTSM is summarized in this section (see protocol HH-7). The source material is preliminarily considered to be PTSM if the cumulative risk exceeds one of the following toxicity threshold criteria:

- Carcinogens - greater than 1E-03 industrial worker risk
- Noncarcinogens – industrial worker hazard index (HI) greater than 10

E.2.1 Screening Evaluation

In the preliminary screen, the unit maximum for every detected constituent (soil, sediment or concrete media as applicable) from all depth intervals is determined and used as the exposure point concentration (EPC) for the risk/hazard calculation. A PTSM Screening Evaluation Table is provided.

E.2.2 Refined Calculation (if needed)

This section presents a refined calculation of risk/hazard using a 95% upper confidence limit on the mean concentration (95%UCL) as the EPC for the constituents that exceed the initial screening evaluation.

E.2.3 Results/Refinement of Constituents of Concern

This section provides an uncertainty evaluation (i.e., weight of evidence) for COCs per the protocol COC-1, *Constituents of Concern (COC) Refinement Process.* The text will refer to tables from Step E.2.1. and E.2.2 as appropriate. A weight of evidence evaluation for any additional considerations is included. Some examples where it may not be appropriate to identify the source term as PTSM include: 1) if the source defined as PTSM is of very limited extent or volume, 2) if the source term appears skewed based on a single value, 3) if a published toxicity value is undergoing additional evaluation, or 4) if the HI exceeds 10 based on the cumulative effects of noncarcinogens that effect different target organs.

E.3 SUMMARY/CONCLUSION OF THE PRINCIPAL THREAT SOURCE MATERIAL EVALUATION

This section is an overall summary of the PTSM evaluation. The refined constituents of concern and corresponding risk hazard/hazard levels for the receptor are identified and reference is made to the refined conceptual site model presented in Section 3.

E.4 REFERENCES

This section provides a list of references that are cited in the PTSM evaluation.

Figures and Tables

A sample list of figures and tables to be included in the PTSM evaluation is provided below.

Figure E-1. Operable Unit Sample Location Map

Table E-1. PTSM Screening Evaluation (all depth intervals)

List of Attachments

Attachment E-1: USEPA Regional Screening Levels Table: RSLs for Default Industrial Worker Scenario *(website accessed date)*

Attachment E-2: USEPA Radionuclide Preliminary Remedial Goals for Superfund Table: PRGs for Default Industrial Worker Scenario *(website accessed date)*

This page is intentionally left blank.

APPENDIX F. PRELIMINARY REMEDIAL GOALS FOR THE OPERABLE UNIT FORMAT

F.1 INTRODUCTION

The purpose of this appendix is to present the preliminary remedial goals (PRGs) for the operable unit (OU). PRGs are potential cleanup levels that are identified/calculated for all of the refined constituents of concern that are problems warranting action. PRG summary tables are included if appropriate.

F.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS PRELIMINARY REMEDIAL GOALS

This section presents the ARAR PRGs for the OU. Chemical-specific ARARs are presented in Section 3 of this document (see protocol ARAR-2, *ARAR Preliminary Remedial Goals*).

F.3 CONTAMINANT MIGRATION PRELIMINARY REMEDIAL GOALS

This section presents the contaminant migration (CM) PRGs for the OU. The CM analysis is presented in Appendix B, *Contaminant Fate and Transport Analysis*, of this document (see protocol CM-3, *Contaminant Migration PRGs*).

F.4 HUMAN HEALTH PRELIMINARY REMEDIAL GOALS

This section presents the human health (HH) PRGs for the OU. The HH risk assessment is presented in Appendix C, *Human Health Risk Assessment*, of this document (see protocol HH-6, *Human Health PRGs*).

F.5 ECOLOGICAL PRELIMINARY REMEDIAL GOALS

This section presents the ecological PRGs for the OU. The ecological risk assessment is presented in Appendix D, *Ecological Risk Assessment*, of this document (see protocol ECO-6, *Ecological PRGs*).

F.6 PRINCIPAL THREAT SOURCE MATERIAL PRELIMINARY REMEDIAL GOALS

This section presents the principal threat source material (PTSM) PRGs for the OU. The evaluation is presented in Appendix E, *Principal Threat Source Material Evaluation*, of this document. PTSM PRGs are established at the 1E-03 risk level or hazard quotient = 10.

APPENDIX G. NATURAL RESOURCE INJURY EVALUATION CHECKLIST FORMAT

The Natural Resource Injury Evaluation Checklist is provided to assist project teams in determining the potential for natural resource injuries in the conduct and planning of remedial activities. For the most part, the questions only require a simple 'yes/no' or 'to be determined' response. Some require a short answer or explanation. However, it is in the best interest of the project team to be as complete as possible and add any relevant information.

Four main areas are evaluated, as follows:

- Are there potential natural resource injuries and what do they consist of?
- What are the potential impacts from implementing the remedial alternatives?
- Are there potential residual injuries that will not be addressed by the alternative?
- What potential irreversible and irretrievable resources may be identified?

The checklist shown below should be re-visited and revised as CERCLA/RCRA activities continue and additional information becomes available.

1. Has a release of a hazardous substance occurred?

2a. Have natural resources for which federal or state agencies (or Indian Tribes) may assert trusteeship under CERCLA been or are likely to have been adversely affected by the release?

Natural resources are defined by Section 101(16) of CERCLA, as "land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other such resources". The National Contingency Plan (NCP) Section 300.600(b) indicates that natural resources may include not only the environmental organisms and abiotic resources, but the "supporting ecosystems associated with the biotic resources" as well. Resources are categorized into five groups: surface water resources, groundwater resources, air resources, geologic resources, and biological resources. Resources can also be classified as direct use (such as drinking water, hunting, etc.) or nonuse (such as aesthetic value or existence). Nonuse services do not require physical or visual contact between people and the resource. Nonuse resources include resources that provide well-being for people (or other flora/fauna) because they exist. For example, nesting sites, threatened and endangered species, natural areas, etc.

2b. List the potentially affected resources (e.g., ground water, waterfowl, etc.).

3. Is the amount of hazardous substance released sufficient to potentially cause a natural resource injury?
4. Will the remedial alternatives being considered, or action already taken, sufficiently address the injuries to natural resources (including residual injuries)?
5. Will the remedial alternatives being considered produce additional impacts to natural resources during remediation? If yes, the potential impacts associated with each alternative need to be identified and discussed in the appropriate documentation including the Feasibility Study, Statement of Basis/Proposed Plan, Record of Decision or permit modification.

The potential costs for addressing resource injuries should be taken into consideration when selecting a remedial alternative. The liability (potential damages) associated with resource injuries could drive the cost of the intended best or lowest cost alternative.

6. Identify any irreversible and/or irretrievable resource losses in the appropriate documentation.

APPENDIX H. DETAILED COST ESTIMATES

The purpose of this appendix is to derive detailed cost estimates for use in Section 5, the CMS/FS, for the purpose of comparing remedial alternatives during the remedy selection process. At the CMS/FS phase, the design for the remedial action project is still conceptual and the cost estimate is considered to be order-of-magnitude. Cost estimates in the CMS/FS are based on an expected accuracy range of -30 to +50 percent for the detailed analysis of remedial alternatives. Cost estimates for each alternative are provided in a tabular format.

This page is intentionally left blank.

APPENDIX I. DATA USABILITY REPORT

The purpose of this appendix is to present the analytical data verification and validation results for the sample events associated with the operable unit. The Data Usability Report is prepared per F-15, *Data Usability Report Format*, and may be submitted separately.

This page is intentionally left blank.

STATEMENT OF BASIS/PROPOSED PLAN FORMAT

The Statement of Basis/Proposed Plan (SB/PP) document is written clearly and concisely since it will likely be read by a broad public audience. The SB/PP tells the story of the Savannah River Site (SRS) and the operable unit (OU) to clearly communicate the contamination problems and the risk they impose. The contents are consisted with the scoping summary document prepared during the SB/PP Scoping phase and are adjusted as needed to support interim actions and early actions. The title and contents are also adjusted to support a Proposed Plan if the OU is Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) only. The SB/PP is presented in a reader-friendly two column format.

I. INTRODUCTION AND BACKGROUND

This section of the SB/PP includes an introduction and summary background of SRS, and summarize the SRS compliance history. It will provide an introduction to the OU addressed by the SB/PP including the media and contaminants, the preferred remedial alternative, and the reason for the preference.

Introduction

This section of the SB/PP includes an introduction and summary background of the SRS, an introduction to the OU addressed by the SB/PP including the media and contaminants, the preferred remedial alternative, and the reason for the preference. Reference maps showing the general location of the SRS, OU, and surrounding features should be provided.

SRS Compliance History

The section summarizes the SRS compliance history including how SRS manages certain waste materials under the Resource Conservation and Recovery Act (RCRA), the listing of SRS on the National Priorities List (NPL), and the integration of the established RCRA Facility Investigation (RFI) program with CERCLA requirements to provide a focused environmental program at SRS. Included is a description of the Federal Facility Agreement (FFA) for the SRS that the United States Department of Energy (USDOE) negotiated with the United States Environmental

Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC), in accordance with Section 120 of CERCLA, 42 U.S.C. § 9620, to coordinate remedial activities into one comprehensive strategy which fulfills these dual regulatory requirements.

The section will explain the requirements that give the public the opportunity to review and comment on the proposed remedial alternatives and the establishment of an Administrative Record File (ARF) that documents the investigation and selection of remedial alternatives and allows for review and comment by the public regarding those alternatives (See Section II). Following the public comment period, the Responsiveness Summary will be prepared to address issues raised during the public comment period.

The section will identify if the remedial decision is final and will/will not require a RCRA permit modification by SCDHEC. The Responsiveness Summary will be made available with the final RCRA permit modification (if appropriate) and the Record of Decision (ROD).

II. COMMUNITY PARTICIPATION

This section identifies where the FFA ARF, which contains the information pertaining to the selection of the response action, is available for public review. The section will identify the locations where hard copies of the SB/PP are available, where the RCRA ARF for SCDHEC is available, how the public is notified of the public comment period, and identify how the public can request a public meeting. If there were any SRS Citizens Advisory Board activities or recommendations regarding the OU, a summary is included in this section.

III. OPERABLE UNIT BACKGROUND

This section briefly describes the OU history including the following information as appropriate:

- History of waste generation or disposal that led to current problems
- History of federal, state, and local site investigations
- Identification of contaminated media at the site (e.g., soil, air, groundwater, and surface water)

- Description of removal or previous remedial actions conducted under CERCLA or other authorities
- Site characteristics including geographical or topographical factors that had a major impact on remedy selection (e.g., resources affected or threatened by site contamination such as current or potential drinking water sources or wetlands)
- Type of contamination and its vertical and lateral extent
- A map that shows location of roads, buildings, drinking water wells, and other characteristics that are important to understanding why the remedial action objectives and preferred alternative are appropriate for the OU
- Principal and low-level threat wastes (e.g., location of mobile/high toxicity/high concentration source material and immobile/low toxicity/low concentration source material)
- A schematic cross section drawing depicting subunits, constituents of concern (COCs), principal threat source material (PTSM), migration route, etc.

IV. SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

This section summarizes the lead agency's overall strategy for remediating the OU and describes how the action being considered in the SB/PP fits into the overall site strategy. If appropriate, a description of how the remediation fits into the SRS Area OU strategy is discussed. This section includes the following information as appropriate:

- Description of the purpose of the SB/PP for the OU. If multiple subunits are present, the purpose for each subunit and its respective media is described.
- Description of any prior or planned remedial or removal actions, interim actions, or early actions for the OU.
- Description of how the response action addresses PTSM.

V. SUMMARY OF SITE RISKS

This section summarizes the extent of contamination at the OU and the risks posed to human health and the environment using information documented in the RFI/Remedial Investigation/Baseline Risk Assessment (RFI/RI/BRA). The summary of site risks should include key findings made in the BRA. This section should clearly link the OU risks to the basis for action for the OU or subunits as appropriate.

Generally, the risk summary in the SB/PP should be a narrative description rather than a tabular presentation. Risk tables are more appropriate for the level of detail needed in a ROD rather than for the SB/PP. The length of most risk descriptions in the SB/PP should be limited to no more than two or three paragraphs (for each subunit, if applicable). For sites that are complex or for sites where there is heightened public interest, more risk assessment information may be needed in the SB/PP. A risk assessor should be consulted if a streamlined risk summary table is presented in the SB/PP to ensure that it is consistent with the summary tables in the risk assessment, informative, and not overly detailed.

Summary of Human Health Risk Assessment

A summary of the human health risk assessment includes the following:

- Major human health COCs in each medium
- Land and groundwater use assumptions
- Potentially exposed populations in current and future risk scenarios (e.g., worker currently on site, adult or children living on site in the future)
- Exposure pathways (routes of exposure) and how they relate to current or reasonably anticipated future land, groundwater, and surface water use
- Estimated cancer and non-cancer risks associated with exposure pathways for COCs that are driving the need to implement the preferred alternative

Summary of Ecological Risk Assessment

A summary of the ecological risk assessment (e.g., the environmental risks associated with specific media, how these risks were determined, and the potential risks to endangered species) includes the following:

- Major ecological COCs in each medium
- Potential ecological receptors, i.e., plant and animal populations, communities, habitats, and sensitive environments
- Potential exposure pathways, i.e., how ecosystems or other ecological receptors are likely to become exposed to COCs
- Potential ecological effects from exposure

Summary of Contaminant Fate and Transport Analysis

A summary of the contaminant fate and transport analysis includes the following as appropriate:

- Major contaminant migration COCs
- Modeled concentration and time to exceed a groundwater protection standard [e.g., maximum contaminant level (MCL)] or a risk-based concentration

Summary of Principal Threat Source Material (PTSM)

This section identifies if source materials exists at the unit that exceeds PTSM levels.

Problems Warranting Action

This section identifies the problem(s) warranting action for the OU. The problem(s) warranting action are listed in bulletized format by subunit, if appropriate. A statement is also included for the subunits and/or media that have no problems warranting action.

Conclusion

The following standard statement that supports the need for taking an action is included in this section unless it is a “No Action” conclusion.

"*It is the lead agency's current judgement that the preferred alternative identified in this SB/PP, or one of the other active measures considered in the SB/PP, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment*."

VI. REMEDIAL ACTION OBJECTIVES

This section briefly describes the remedial action objectives (RAOs) for the OU and how they mitigate site risks (e.g., prevent contamination from reaching the groundwater by treating the contaminated soils, etc.). The assumed future land use (i.e., industrial, unrestricted, etc.) is identified with a description of how the RAOs support that future land use. The RAOs are listed in bullet form and by subunit if appropriate.

Preliminary Remedial Goals[1]

This section presents and describes the basis for the preliminary remedial goals (PRGs) (e.g., PRG of 5 ppm for trichloroethylene is based on the federal MCL for drinking water). A table that presents the range of PRGs for the receptor(s) and media of concern is provided. A discussion of ecological receptors and PRGs is included if appropriate.

Applicable or Relevant and Appropriate Requirements (ARARs)

This section provides a description of the three categories of Applicable or Relevant and Appropriate Requirements (ARARs) (action-specific, location-specific, and chemical-specific) and references the table that identifies the ARARs for the preferred remedial alternative.

VII. SUMMARY OF REMEDIAL ALTERNATIVES

This section provides a brief narrative description of the remedial alternatives evaluated including remedy components and distinguishing features unique to each alternative. A minimum of three alternatives are evaluated unless the USEPA and SCDHEC agree to a unit-specific exception. For example, if a No Action Alternative and a Land Use Control Alternative are under consideration,

[1] Preliminary remedial goals were formerly known as remedial goal options in earlier SRS regulatory documentation.

a third alternative that reduces the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants must also be included.

Examples of remedy components for the narrative discussion may include the following:

- Treatment technologies employed and how they will reduce the intrinsic threat posed by the contamination
- Engineered controls including temporary storage and permanent on-site containment
- Land use controls (LUCs) that will restrict access and limit future activities that might result in increased exposure to contamination. The LUCs should be descriptive and specific for the remedy. LUCs may include engineering controls such as warning signs or fencing and institutional controls (e.g., deed restrictions, excavation permit restrictions, etc.).

Distinguishing features will vary based on remedy specifications. Examples of distinguishing features for the narrative discussion may include the following:

- RAOs to be achieved by the alternative (e.g., return surface water to recreational use)
- Estimated quantities of material to be addressed by major components
- Implementation requirements (e.g., the need for an off-site disposal facility)
- Reasonably anticipated future land use and whether or not appropriate contamination levels will be achieved by the alternative
- A summary level narrative of ARARs evaluated for each alternative, with emphasis on key ARARs that differ from those that must be attained by other alternatives. No ARARs are required for LUC only remedies. Any proposed ARAR waivers and any RCRA treatability or no migration variances will be discussed.
- Use of presumptive remedies or innovative technologies
- Estimated time to construct and implement the remedy until RAOs are met. Time savings if schedule was accelerated (i.e., previous removal actions, etc.) are discussed.
- Expected outcomes (e.g., RAOs that the alternative will attain)

- Estimated costs

Estimated costs include the capital cost, operations and maintenance cost, and present worth cost. A reference to the detailed costs estimate tables in the appendices is provided and a summary of the costs for each alternative may also be shown in the text.

In instances where a Corrective Measures Study/Feasibility Study (CMS/FS) report was not required, the SB/PP will state that a CMS/FS was not needed (including reasons) and that the SB/PP is modified to add some items that normally would have appeared in a CMS/FS. In general, the screening of alternatives, comparison of alternatives, and detailed present value cost estimates for the alternatives may be added to the appendices.

VIII. EVALUATION OF ALTERNATIVES

This section summarizes the results of the evaluation of the remedial alternatives in the CMS/FS (or SB/PP appendices if no CMS/FS was prepared). A reference to the table detailing the nine CERCLA evaluation criteria is provided. The nine CERCLA evaluation criteria fall into three categories of threshold criteria, primary balancing criteria, and modifying criteria.

Comparative Analysis of Alternatives

This section provides a summary of the comparison of the alternatives against the CERCLA evaluation criteria. Key advantages and disadvantages for each alternative relative to one another and in relation to the two threshold criteria and five primary balancing criteria are discussed below and summarized in a table. The two modifying criteria (i.e., state or support agency acceptance and community acceptance) are evaluated after the SB/PP public comment period.

Overall Protection of Human Health and the Environment

Each alternative is evaluated on the basis of how the alternative eliminates, reduces, or controls the risk of exposure to contaminants through engineered or institutional controls or treatment. Each alternative is examined as to whether it creates any unacceptable short-term risks to human health.

Compliance with ARARs

This section evaluates each alternative as to whether it meets cleanup standards, or other substantive requirements, criteria, or limitations promulgated under federal, state, or local environmental law. Each alternative is discussed with respect to chemical-, action-, and location-specific ARARs. Any ARAR waivers and the justification for invoking the waiver are discussed. This section may also identify "to-be-considered" advisories, criteria, or guidance, including USDOE Orders.

Short-Term Effectiveness

This section considers the length of time needed to implement each alternative and the risks posed to workers, residents, and the environment during remedy implementation and whether each alternative meets cleanup standards. A statement of the potential for each remedial alternative to avoid, mitigate, compensate for, or cause or increase injury to a natural resource is included.

Long-Term Effectiveness and Permanence

This section evaluates each alternative's ability to maintain protection of human health and the environment over time. The magnitude of residual risk and reliability of controls is discussed.

Reduction of Toxicity, Mobility, or Volume through Treatment

This section discusses whether each alternative uses treatment to reduce the harmful effects of principal contaminants, the amounts of hazardous materials destroyed or treated, the degree of expected reductions in toxicity, mobility, or volume, the degree to which treatment is irreversible, and the type and quantity of residuals remaining after treatment.

Implementability

This section evaluates the technical and administrative feasibility to implement each alternative. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until the remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components into the future if needed after the remedial action is complete. Administrative feasibility refers to the ability to

obtain approvals from other offices and agencies, availability of equipment and technologies, and availability of off-site treatment, storage, and disposal services if appropriate.

Cost

This section compares the cost of each alternative. Cost includes estimated capital cost, annual operations and maintenance costs, and present worth costs. A reference is included to the detailed cost estimate for the preferred alternative in the appendices.

IX. PREFERRED ALTERNATIVE

This section identifies the Preferred Alternative and provides the most compelling reason(s) for preferring this alternative. This should compare the preferred alternative to each of the other alternatives and point out the most decisive considerations for making the selection. Maps and figures, as necessary, are used to illustrate the preferred alternative. The argument should be convincing and not leave questions as to why some other alternative was not preferred and include the following as appropriate:

- Discussion of how the remedy meets the RAOs and key ARARs
- Discussion of important advantage(s) over the other alternatives that were evaluated
- Discussion of any uncertainties or contingency measures
- A description of the expected outcomes of the Preferred Alternative, including risk reduction (how risks identified in the BRA will be addressed)
- If groundwater monitoring is required, monitoring and performance/effectiveness requirements are described using maps and figures, as appropriate
- Discussion of OU-specific LUCs (i.e., soil cover, plugging and grouting of manholes and pipelines, signage at the OU boundaries, etc.), institutional controls (i.e., administrative controls) and use restrictions for on-site workers via the Site Use/Site Clearance Program, and other administrative controls to ensure worker safety including work controls, worker training, and worker briefing of health and safety requirements

- Discussion of SRS access controls against trespassers as described in the current RCRA Permit Renewal Application, Volume I, Section F.1, which describes the security procedures and equipment, 24-hour surveillance system, artificial or natural barriers, control entry systems, and warning signs in place at the SRS boundary

This section discusses if the preferred remedy for the OU leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for an indefinite period of time. Reference is included to the SRS Land Use Control Assurance Plan and the need for an OU-specific Land Use Control Implementation Plan that provides details and specific measures required for the LUCs selected as part of the preferred remedy.

The text should include a summary of the support agencies' concurrence or non-concurrence with the Preferred Alternative, if known. A summary statement by the lead agency is included at the end of this section similar to the following:

"*Based on information currently available, the lead agency believes that [identify preferred alternative] provides the best balance of tradeoffs among the other alternatives with respect to the evaluation criteria. The USDOE expects the Preferred Alternative to satisfy the statutory requirements in CERCLA Section 121(b) to: (1) be protective of human health and the environment, (2) comply with ARARs (or justify a waiver), (3) be cost-effective, (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable, and (5) satisfy the preference for treatment as a principal element (or justify not meeting the preference)*."

X. POST-ROD SCHEDULE

For final actions (or interim or early actions), an implementation schedule showing the ROD date, post-ROD document submittals, and Remedial Action Start date is included.

XI. REFERENCES

This section provides a list of the documents that are referred to in the SB/PP and may include the following reference document.[2]

A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, OSWER Directive 9200.1-23P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., July 1999.

XII. GLOSSARY

This section provides a description of key terms used in this document (i.e., ARAR, CERCLA, deactivation, decommissioning, National Contingency Plan, low-level waste, etc.).

Figures and Tables

A sample of the figures and tables that may be included in the SB/PP are listed below. Figures and tables may also be presented in appendices. Figures and tables will be specific for the OU.

Figure 1. Location of the OU within the Savannah River Site
Figure 2. Layout of the OU
Figure 3. Schematic Cross Section of the OU
Figure 4. Post-Record of Decision Implementation Schedule

Table 1. Summary of the Preliminary Remedial Goals for the OU
Table 2. Potential ARARs for the Preferred Remedial Alternative for the OU
Table 3. Cost Estimate for the Preferred Alternative
Table 4. Description of the CERCLA Evaluation Criteria
Table 5. Comparison of Alternatives Against the CERCLA Evaluation Criteria
Table 6. Comparative Ranking of OU Remedial Alternatives

[2] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

STATEMENT OF BASIS/PROPOSED PLAN FACT SHEET FORMAT

The Statement of Basis/Proposed Plan (SB/PP) Fact Sheet provides a shorter summary of the remedy selection process with less technical information to ensure the widest possible audience is reached. The Fact Sheet is submitted to the regulatory agencies with the SB/PP document. The "Statement of Basis" terminology is not used if prepared for a Comprehensive Environmental Response, Compensation, and Liability Act operable unit. A sample "template" for preparation of a SB/PP Fact Sheet is shown below.

Savannah River NUCLEAR SOLUTIONS™
FLUOR • NEWPORT NEWS NUCLEAR • HONEYWELL

United States Department of Energy
Statement of Basis/Proposed Plan Fact Sheet
for the [OU NAME]
SRNS-RP-20XX-XXXX

Savannah River Site, South Carolina **Month Year**

INTRODUCTION

This fact sheet summarizes the Statement of Basis/Proposed Plan for the [OU Name] located at the Savannah River Site (SRS). The United States Department of Energy (USDOE) owns and operates the SRS. Hazardous substances that are regulated under the federal law requirements of the Resource Conservation and Recovery Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) are managed at the SRS as part of a comprehensive cleanup program.

A remedial action is needed at the [OU Name] because [list contaminants] are present in [list media, i.e., soil, sediment, surface water, and/or groundwater] that may pose a threat to human health and the environment. The Statement of Basis/Proposed Plan for the [OU Name] outlines the range of remedial alternatives evaluated to clean up the contaminated [list media] and presents the proposed remedy. The document describes how the public can comment on the proposed action through written comments and by participating in public meetings.

BACKGROUND

This section briefly describes the OU history including the following:

- Description of the OU including the location and size;
- A current photograph of the OU if available or a figure that presents the layout of the OU;

- The history of waste generation or disposal that led to current problems;
- Identification of contaminated media at the site (e.g., soil, air, groundwater, and surface water). If the OU consists of multiple subunits, information is presented on a subunit-by-subunit basis;
- A description of any previous removal or remedial actions at the OU conducted under CERCLA or other authorities; and
- A discussion of the contaminants of concern, risk evaluation results, and land use. Public-friendly definitions of risk, hazard, principal threat source material (PTSM), etc., are presented such as the following:
    - A risk greater than or equal to 1E-06 indicates a probability of 1 chance in 1,000,000 of an individual developing cancer under the exposure scenarios evaluated.
    - A hazard quotient greater than or equal to 1 indicates that an individual could experience adverse health effects from exposure to the contaminant.
    - Principal threat source materials (PTSM) are described as highly toxic materials that would present a significant risk to human health or the environment should exposure occur.

CLEANUP GOALS

This section summarizes the contaminants of concern (i.e., human health, ecological, PTSM, and contaminant migration) and briefly describes the cleanup goals. Examples of cleanup goals may include one or more of the following:

- Prevent exposure of human receptors (i.e., industrial workers and/or residents) to [identify contaminants] in [identify media and depth if appropriate].
- Prevent exposure of ecological receptors [identify receptors] to [identify contaminants] in [identify media and depth if appropriate].
- Prevent migration of contaminants in soil [identify depth if appropriate] to groundwater at levels that could exceed a regulatory standard (e.g., maximum contaminant levels)
- Remove or treat PTSM located in [identify media and depth if appropriate] that exceeds a risk to the industrial worker greater than 1E-03.
- Prevent exposure of industrial workers and potential residents to buried friable asbestos.
- [Others as needed.]

PROPOSED REMEDY

This section describes the proposed remedial action and explains how it meets the cleanup goals. If appropriate, a statement that the USDOE will restrict land use through administrative measures and the placement and maintenance of signs at the OU is included. A statement is included that the United States Environmental Protection Agency and South Carolina Department of Health and Environmental Control (SCDHEC) concur with the proposed remedy.

FOR MORE INFORMATION

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

US Department of Energy
Public Reading Room
Gregg-Graniteville Library
University of South Carolina – Aiken
471 University Parkway
Aiken, South Carolina 29803
(803) 641-3504

Thomas Cooper Library
Government Information and Maps
Department
University of South Carolina
1322 Greene Street
Columbia, South Carolina 29208
(803) 777-4841

Hard copies of the Statement of Basis/Proposed Plan for the [OU Name] are available at those locations and also at the following locations during the public comment period:

Reese Library
Government Information Department
Augusta University
2500 Walton Way
Augusta, Georgia 30904
(706) 737-1744

Asa H. Gordon Library
Savannah State University
2200 Tompkins Road
Savannah, Georgia 31404
(912) 358-4324

The SB/PP is also available online for public review and comment at [URL].

HOW TO SUBMIT COMMENTS

The public comment period for the Statement of Basis/Proposed Plan for [OU Name] begins [date] and ends [date]. To request a public meeting during the public comment period, to obtain more information concerning this document, or to submit written comments, contact one of the following: [The SCDHEC contact information is deleted if this is a CERCLA only OU.]

[Contact Name] Savannah River Nuclear Solutions, LLC Savannah River Site Building 730-1B Aiken, South Carolina 29808 [Contact phone] [Contact email]	The South Carolina Department of Health and Environmental Control Attn: [Contact Name] Division of Waste Management Bureau of Land and Waste Management 2600 Bull Street Columbia, South Carolina 29201 (803) 898-2000

The following reference document may be used for the development of the SB/PP fact sheet.[1] A reference section is normally not published in the fact sheet.

A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, OSWER Directive 9200.1-23P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., July 1999.

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

RECORD OF DECISION FORMAT

PART 1: DECLARATION FOR THE RECORD OF DECISION

The Declaration functions as the abstract and data certification sheet for the key information in the Record of Decision (ROD) and is the formal authorizing signature page. The language in the ROD is adjusted as appropriate to accommodate an Interim ROD (IROD), Early Action ROD (EA ROD), or No Action ROD (i.e., no action remedial decision).

Unit Name and Location

This Declaration section lists the proper name of the operable unit (OU), Superfund Enterprise Management System (SEMS) Identification Number, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number, and city and state where the OU is located. The section identifies the listing of the OU in Appendix C of the Federal Facility Agreement (FFA) for the Savannah River Site (SRS) as a Resource Conservation and Recovery Act (RCRA)/CERCLA unit or CERCLA only unit.

The FFA is a legally binding agreement between regulatory agencies (United States Environmental Protection Agency [USEPA] and South Carolina Department of Health and Environmental Control [SCDHEC]) and regulated entities (United States Department of Energy [USDOE]) that establishes the responsibilities and schedules for the comprehensive remediation of SRS. The Declaration section lists the media associated with the OU, site-specific factors that require consideration during the remediation, and addresses whether groundwater is part of the OU or addressed by a separate groundwater OU.

If this is an interim action, this section discusses the SRS RCRA permit renewal modification process applicability to the interim action similar to the following:

> *"An SRS RCRA permit renewal modification is not required at this time since this is an interim action. However, the RCRA permit renewal will be revised to reflect selection of the final remedy using the procedures under 40 Code of Federal Regulation (CFR) Part*

270, and South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.264.101; 270."

Statement of Basis and Purpose

This Declaration section contains the factual and legal basis for the selected remedy and states that the information supporting the decision is located in the Administrative Record File (ARF). The section states whether the USEPA, SCDHEC, and USDOE concur with the selected remedy.

Assessment of the Site

This Declaration section includes a statement that identifies the existence of a release or substantial threat of release of hazardous substances in the environment. A statement is provided that the response action selected in the ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

For No Action RODs, language is included that there is no current or potential threat to public health, welfare, or the environment from the OU.

Description of the Selected Remedy

This Declaration section identifies the future land use assumed for the OU and provides a brief description of the selected remedy and the major components of the remedy (i.e., land use controls [LUCs], treatment technologies and/or engineering controls if appropriate, time to complete construction, etc.). This section describes how the selected remedy addresses principal threats at the site (i.e., what is being treated, what is being contained, and what is the rationale for each). If LUCs are part of the remedy, those activities the LUCs are designed to protect are specified, and the LUC objectives are listed in bulleted format. A description is provided of the scope and role of the OU within the overall SRS management strategy as appropriate.

For No Action RODs, language is included that the OU poses no unacceptable risk based on an unlimited exposure and an unrestricted land use scenario.

This Declaration section concludes with a statement for RCRA/CERCLA OUs that the RCRA permit will be revised to reflect selection of the final remedy using the procedures under 40 CFR Part 270, and SCHWMR R.61-79.264.101; 270. This statement is not included for CERCLA-only OUs.

Statutory Determinations

This Declaration section provides a confirmatory statement that the selected remedy satisfies the statutory requirements of CERCLA. Language consistent with the text shown below is used as appropriate for the OU.

For No Action remedies, the following language is used:

> *"Based on the OU [RCRA Facility Investigation/Remedial Investigation with Baseline Risk Assessment (RFI/RI/BRA) report or RI/BRA report if CERCLA-only OU], the [OU name] does not pose a threat to human health and the environment. No Action has been selected as the remedy, and the future land use of the [OU name] will be unrestricted. Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, five-year review will not be required for this remedial action."*

For remedies that are not No Action, the following language is used:

> *"Based on the OU [RCRA Facility Investigation/Remedial Investigation with Baseline Risk Assessment (RFI/RI/BRA) report or RI/BRA report if CERCLA-only OU], the [OU name] poses a threat to human health and the environment. Therefore, [selected remedial alternative title], has been selected as the remedy for the [OU name]. As part of the selected remedy, the future land use of the [OU name] will be [industrial or other non-residential use]."*

If the five-year remedy review is applicable, the following language is used:

> *"In accordance with Section 121(c) of CERCLA and National Contingency Plan and Hazardous Substances Pollution Contingency Plan, referred to as the National*

Contingency Plan (NCP), §300.430(f)(5)(iii)(c), a statutory review will be conducted within five years of initiation of the remedial action and every five years thereafter, to ensure that the remedy continues to be protective of human health and the environment."

If the selected remedy satisfies the CERCLA 121 preference for treatment as a principal element, the following language is used:

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

If the selected remedy does not satisfy the preference for treatment as a principal element, the following language is used:

"The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action (unless justified by a waiver), and is cost-effective. The remedy in this OU does not satisfy the statutory preference for treatment as a principal element of the remedy for the following reasons (reasons listed)."

For an interim action, the following language is used:

"This interim action is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the limited-scope remedial action (unless justified by a waiver), and is cost-effective. This action is interim and is not intended to utilize permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this OU. ***[Note: where treatment is utilized, the prior sentence is replaced with the following sentence:*** *Although this interim action is not intended to fully address the statutory mandate for permanence and treatment to the maximum extent practicable, this interim*

*action utilizes treatment and thus is in furtherance of that statutory mandate.] Because this action does not constitute the final remedy for the [OU name], the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element [**Note: Include if treatment is part of the interim remedy:** although partially addressed in this remedy] will be addressed by the final response action. Subsequent actions are planned to fully address the threats posed by the conditions at this OU.*

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after commencement of the remedial action and every five years thereafter, to ensure that the remedy continues to provide adequate protection of human health and the environment. Because this is an Interim ROD (IROD), review of this OU and of this remedy will be continuing as USDOE continues to develop final remedial alternatives for the [OU name].”

For remedies that invoke an applicable or relevant and appropriate requirement (ARAR) waiver, a statement to that effect is included. For example, in the case of an action that invokes a maximum contaminant level (MCL) waiver, the following statement is used:

“An applicable or relevant and appropriate requirement (ARAR) waiver under §300.430(f)(1)(ii)(C) of the NCP for all groundwater constituents of concern (COCs) has been invoked because the selected remedy is an interim action measure that will become part of a total remedial action that will ultimately attain ARARs (MCLs).”

For remedies that include LUCs, the following language is used:

“In the long term, if the property, or any portion thereof, is ever transferred from USDOE, the U.S. Government and/or USDOE will take those actions necessary pursuant to Section 120(h)(1) of CERCLA. Those actions will include in any contract, deed, or other transfer document, notice of the type and quantity of any hazardous substances that were known to have been stored (for more than one year), released, or disposed of on the property. The notice will also include the time at which the storage, release, or disposal took place to the extent such information is available.

In addition, if the property, or any portion thereof, is ever transferred by deed, the U.S. Government will also satisfy the requirements of CERCLA 120(h)(3). The requirements include a description of the remedial action taken, a covenant, and an access clause. ***[Note: the following sentence is not needed if a CERCLA-only OU].*** *These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the OU.*

LUCs will be implemented through the following:

- *The contract, deed, or other transfer document shall also include restrictions precluding residential use of the property. However, the need for these restrictions may be reevaluated at the time of transfer in the event that exposure assumptions differ and/or the residual contamination no longer poses an unacceptable risk under residential use. Any reevaluation of the LUCs will be done through an amended ROD with USEPA and SCDHEC review and approval.*
- *In addition, if the site is ever transferred to nonfederal ownership, a survey plat of the OU will be prepared, certified by a professional land surveyor, and recorded with the appropriate county recording agency.*

In the event of a property lease or interagency agreement, the equivalent restrictions will be implemented as required by CERCLA Section 120(h).

The selected remedy for the [OU name] leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for as long as necessary to keep the selected remedy fully protective of human health and the environment. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a Land Use Control Assurance Plan (LUCAP) [reference] to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The OU-specific Land Use Control Implementation Plan (LUCIP) incorporated by reference into this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for

implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the [Corrective Measures Implementation Plan (CMIP)/Remedial Action Implementation Plan (RAIP) or RAIP if CERCLA-only], as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the OU. The LUCIP will remain in effect unless and until modifications are approved by the USEPA and SCDHEC as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document."

Data Certification Checklist

The Declaration will certify that the following information is included in the ROD (or a brief explanation for why this information is not included is provided).

"This ROD provides the following information: [ROD document section numbers are provided for each bullet item]

- *COCs and their respective concentrations*
- *Baseline risk represented by the COCs*
- *Cleanup levels established for the COCs and the basis for the levels*
- *Current and reasonably anticipated future land and groundwater use assumptions used in the BRA and ROD*
- *Potential land and groundwater use that will be available at the OU as a result of the selected remedy*

- *Estimated capital, operation and maintenance, and total present worth cost, discount rate applied, and the number of years over which the remedy cost estimates are projected*
- *Key decision factor(s) that led to selecting the remedy (i.e., a description of how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria is provided)*
- *How source materials constituting principal threats are addressed"*

Authorizing Signatures and Acceptance of Remedy (end of Declaration section)

The Declaration serves as the formal authorizing signature page for the ROD. A signature page is included at the end of the Declaration section. Representatives from USEPA, SCDHEC, and USDOE, to whom signature authority has been delegated, co-sign the ROD to document concurrence with the selected remedy.

PART 2: THE DECISION SUMMARY

The Decision Summary identifies the selected remedy, explains how the remedy fulfills statutory and regulatory requirements, and provides a substantive summary of the Administrative Record File (ARF) that supports the remedy selection decision. The language in the Record of Decision (ROD) is adjusted as appropriate to accommodate an Interim ROD (IROD), Early Action ROD (EA ROD), or No Action ROD (i.e., no action remedial decision).

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

This section briefly provides the following information:

- Basic information about the operable unit (OU) including the proper name of the OU, Superfund Enterprise Management System Identification Number, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Identification Number, and city and state where the OU is located.
- Brief description of the Savannah River Site (SRS) including the physical location, primary mission, and statement that hazardous substances, as defined by CERCLA, are currently present in the environment at SRS.
- Listing of the OU in Appendix C of the Federal Facility Agreement (FFA) for the SRS as a Resource Conservation and Recovery Act (RCRA)/CERCLA unit or CERCLA-only unit requiring further evaluation.
- [For RCRA/CERCLA OU] Statement that the OU was evaluated through an investigation process that integrates and combines the RCRA corrective action process with the CERCLA remedial process to determine the actual or potential impact to human health and the environment of releases of hazardous substances to the environment.

  [For CERCLA-only OU] Statement that the OU was evaluated through an investigation CERCLA remedial process to determine the actual or potential impact to

human health and the environment of releases of hazardous substances to the environment

- References to figures (e.g., location map of the SRS, watershed map, etc.)

II. SITE AND OPERABLE UNIT COMPLIANCE HISTORY

SRS Operational and Compliance History

This section provides a brief description of the primary mission of SRS, past disposal practices resulting in soil and groundwater contamination, and the SRS compliance history. Language consistent with the text shown below is used in ROD documents.

"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 receives a RCRA hazardous waste permit renewal from the SCDHEC. Module VIII of the Hazardous and Solid Waste Amendments (HSWA) portion of the RCRA permit renewal mandates corrective action requirements for non-regulated solid waste management units subject to RCRA 3004(u).

On December 21, 1989, SRS was included on the National Priorities List. The inclusion created a need to integrate the established 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, USDOE has negotiated a FFA [reference] with USEPA and SCDHEC to coordinate remedial activities at SRS into

one comprehensive strategy 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 SCDHEC."

Operable Unit Operational and Compliance History

This section provides a brief summary of the operational and compliance history for the OU including the following information:

- A brief description of the operating history and how the OU received waste that led to the current problems warranting response action.
- An overview of the OU including the size of the site (e.g., acres).
- A description of surface and subsurface features (e.g., number and volume of tanks, lagoons, structures, drums, etc.).
- Geographical and topographical information (e.g., surface waters, flood plains, wetlands). If groundwater is in the OU, the location of drinking water source wells is provided.
- Document submittal and history information including any prior removal and remedial actions conducted under CERCLA or other authorities.
- Reference to figures (e.g., location maps, layout of the OU within a watershed, subunit map, etc.) and other graphical presentations, as appropriate.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

This section describes how the public participation requirements in CERCLA and the National Contingency Plan and Hazardous Substances Pollution Contingency Plan, referred to as the National Contingency Plan (NCP), were met in the remedy selection process (i.e., community involvement plans, public notices, public meetings, etc.) and other community outreach and involvement efforts. The section provides the public with the location and contact information for the FFA ARF and the RCRA ARF for SCDHEC which contains the information pertaining to the

selection of the response action. Language consistent with the text shown below is used in ROD documents.

> *"Both RCRA and CERCLA require the public to be given an opportunity to review and comment on the draft permit modification and proposed remedial alternative. Public participation requirements are listed in South Carolina Hazardous Waste Management Regulations (SCHWMR) R.61-79.124 and Sections 113 and 117 of CERCLA (42 United States Code Sections 9613 and 9617). These requirements include establishment of an ARF that documents the investigation and selection of the remedial alternative for addressing the [OU name] soils and groundwater. The ARF must be established at or near the facility at issue.*
>
> *The SRS FFA Community Involvement Plan [reference] is designed to facilitate public involvement in the decision-making process for permitting, closure, and the selection of remedial alternatives. The plan addresses the requirements of RCRA, CERCLA, and the 1969 National Environmental Policy Act (NEPA). SCHWMR R.61-79.124 and Section 117(a) of CERCLA, as amended, require the advertisement of the draft permit modification and notice of any proposed remedial action, and provide the public an opportunity to participate in the selection of the remedial action. The [Statement of Basis/Proposed Plan (SB/PP) document name or PP document name if CERCLA-only], a part of the ARF, highlights key aspects of the investigation and identifies the preferred action for addressing the [OU name].*
>
> *The FFA ARF, which contains the information pertaining to the selection of the response action, is available at the following locations:*
>
> *US Department of Energy*
> *Public Reading Room*
> *Gregg-Graniteville Library*
> *University of South Carolina – Aiken*
> *471 University Parkway*
> *Aiken, South Carolina 29803*
> *(803) 641-3504*
>
> *Thomas Cooper Library*
> *Government Information and Maps Department*
> *University of South Carolina*
> *1322 Greene Street*
> *Columbia, South Carolina 29208*
> *(803) 777-4841*

The RCRA ARF for SCDHEC is available for review by the public at the following locations:

The South Carolina Department of Health and Environmental Control
Bureau of Land and Waste Management
2600 Bull Street
Columbia, South Carolina 29201
(803) 898-2000

The South Carolina Department of Health and Environmental Control
Aiken Environmental Affairs Office
206 Beaufort Street, Northeast
Aiken, South Carolina 29801
(803) 642-1637"

***[For an interim action, the following language is included:** "An SRS RCRA permit renewal modification is not required at this time since this is an interim action. However, the RCRA permit renewal will be revised to reflect selection of the final selected remedy using the procedures under 40 CFR Part 270 and SCHWMR R.61-79.264.101; 270.]"*

Language consistent with the text shown below is used in this section.

"The public was notified of the public comment period through mailings of the SRS Environmental Bulletin, a newsletter sent to citizens in South Carolina and Georgia, and through notices in the Aiken Standard, The Augusta Chronicle, The People-Sentinel, and The State newspapers. The public comment period was also announced on local radio stations.

The SB/PP 45-day [or 30-days for IAPPs and PPs] public comment period began on [start date] and ended on [end date]. A Responsiveness Summary, prepared to address any comments received during the public comment period, is provided in Appendix A of the ROD. A Responsiveness Summary will also be available with the final RCRA permit renewal."

A summary is included in this section if there were any SRS Citizen Advisory Board (CAB) activities or recommendations regarding the OU.

IV. SCOPE AND ROLE OF THE OPERABLE UNIT

Due to the complexity and size of multiple waste units in different areas, the SRS is divided into six watersheds (i.e., Upper Three Runs, Lower Three Runs, Fourmile Branch, Steel Creek, Pen Branch, and the Savannah River) for the purpose of managing a comprehensive cleanup strategy. This section identifies the watershed the OU is located in, summarizes the lead agency's overall strategy for remediating the OU, and describes how the remedial action fits into the overall SRS cleanup strategy. A brief discussion of the scope of the problem(s) that will be addressed by the remedial action is included. If multiple subunits are present, the purpose for each subunit and its respective media is described.

If the ROD also addresses a SRS Area OU, a brief summary of the SRS accelerated cleanup plan to implement an area-by-area strategy is included. A statement is included that the USDOE, USEPA, and SCDHEC convened and agreed that using the Area OU strategy to manage surface units at the [OU acronym] was appropriate and the waste units and facilities in the area were consolidated to form a single Area OU.

For IRODs, a statement is included that the OU response action will be consistent with the final action selected for the OU.

V. OPERABLE UNIT CHARACTERISTICS

The characteristics of the OU are presented in this section including references to maps, figures, and photos, as appropriate, to depict the nature and extent of contamination. For an interim or early action, this section will focus on the description of those OU characteristics to be addressed by the interim or early remedy. The OU characteristics are described by subunit when appropriate.

Conceptual Site Model for the Operable Unit

This section discusses the primary and secondary sources of contamination and release mechanisms, contaminated media, migration pathways, exposure pathways, and potential receptors.

Media Assessment

This section presents a brief description of the media assessment (i.e., number of samples, depth intervals, constituents analyzed, etc.), and provides a reference to the characterization activities (i.e., RFI/RI Work Plan, etc.). The information may be presented by media subheadings (i.e., soil investigation, sediment investigation, groundwater investigation, surface water investigation) or presented by subunit if more reader-friendly. In that case, a brief description of the characterization efforts for each subunit is provided.

Media Assessment Results

The results of the media investigation are summarized in this section. A reference to a schematic cross section of the OU is provided, as appropriate. The types of contamination by affected media (e.g., soils, vadose zone, and groundwater) or by discrete subunit (if more appropriate) are included in addition to the following information.

- RCRA listed or characteristic hazardous wastes at the OU are identified.
- The quantity/volume of waste that needs to be addressed is identified.
- Constituents of concern (COCs) in each medium are presented.
- Types and characteristics of COCs (e.g., toxic, mobile, carcinogenic, noncarcinogenic) are presented.
- Principal threat wastes at the OU (e.g., location of mobile/high toxicity source materials) are presented.

Site Specific Factors

Any other site-specific factors that may affect response actions at the OU are included in this section. If there are none, the following statement is included:

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

Contaminant Transport Analysis

This section describes the location of contamination and known or potential routes of off-site migration including the following:

- Likelihood for migration of COCs.
- Population and environmental areas that could be affected, if exposed.
- Lateral and vertical extent of contamination.
- Current and potential surface and subsurface pathways of migration.

For sites with groundwater contamination, the following information is provided, if appropriate.

- Aquifer(s) affected or threatened by OU contamination, types of geologic materials, approximate depths, and whether aquifer is confined or unconfined.
- Groundwater flow directions within each aquifer and between aquifers and groundwater discharge locations (e.g., surface waters, wetlands, other aquifers).
- Confirmed or suspected presence and locations of non-aqueous phase liquids.
- Groundwater transport models and assumptions used to define fate and transport of COCs (if model was used).
- Surface and subsurface features (e.g., number and volume of tanks, lagoons, structures, drums at the site).
- Interconnection between surface contamination (e.g., soils, surface water/sediments) and groundwater contamination.

VI. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

This section describes the current and anticipated future land use for the OU. If appropriate, current adjacent/surrounding land uses may be included.

A specific statement describing the reasonably anticipated future land use and assumptions used to evaluate the remedial actions for the OU is important. Language consistent with the text shown below is used in ROD documents.

> *"According to the SRS Future Use Project Report (reference), residential uses of SRS land should be prohibited. The Land Use Control Assurance Plan (LUCAP) for the SRS [reference] designates the [OU name] as being within an [administrative, industrial] area. The future land use is reasonably anticipated to remain [industrial] with USDOE maintaining control of the land."*

Groundwater Uses/Surface Water Uses

This section identifies any current ground/surface water uses at the OU and in its vicinity. Potential beneficial ground/surface water uses (e.g., potential drinking water, irrigation, recreational) and bases for future use assumptions are described. If beneficial use is a potential drinking water source, the appropriate time frame of projected future drinking water uses (e.g., groundwater aquifer not currently used as a drinking water source, but expected to be utilized in 30-50 years) is provided. The location of the anticipated use in relation to location and anticipated migration of contamination is provided.

If groundwater is not part of the OU, a statement similar to the following is included to identify the OU that will address the groundwater.

> *"Groundwater is not part of the [OU name] and will be addressed separately as part of the [groundwater OU name]."*

VII. SUMMARY OF OPERABLE UNIT RISKS

Baseline Risk Assessment

This section briefly summarizes the Baseline Risk Assessment (BRA) process and results utilizing text and table formats. This section will focus on the information that is driving the need for the specific response action described in the ROD. This section is not intended to provide a summary

of the entire BRA process, and previous BRA documentation (e.g., RCRA Facility Investigation/Remedial Investigation with BRA [RFI/RI/BRA]) will be referenced as appropriate. The risk may be presented by subunit if more reader-friendly.

Summary of Human Health Risk Assessment

A combination of text and table formats are used to provide the following information.

Identification of Human Health COCs

- COCs in each medium
- Minimum/maximum detects and frequency
- Data quality
- Exposure point concentration for each COC (95% UCL)

Exposure Assessment

- CSM reference to show exposure scenarios and pathways
- Potentially exposed populations in current/future scenarios
- Sensitive sub-populations
- Routes of exposure

Toxicity Assessment

- Carcinogenic/non-carcinogenic toxicity data used to calculate risk of each COC
- Source of toxicity information
- Primary target organs/health effects non-carcinogenic COCs

Risk Characterization

- Carcinogenic risks for each COC by medium and pathway
- Combined carcinogenic risks for total exposure to COCs in medium and pathway
- Hazard Quotient (HQ) for each COC in each medium for each pathway

- Hazard Index (HI) for combined non-carcinogenic effects
- Combined carcinogenic and HIs for paths to which individuals could be exposed
- Table summary

Summary of Ecological Risk Assessment

Identification of Ecological COCs

A combination of text and table formats are used to provide the following information.

- Summary of toxicity data used to identify/evaluate constituents of potential concern (COPCs)
- COPCs/COCs in each medium
- Ecological HQs for each COPC/COC
- Data quality

Exposure Assessment

- Description of ecological setting (habitat maps, sensitive areas, etc.)
- Key species exposed and threatened, endangered species
- Exposure pathways for receptors
- Monitoring/modeling data and assumptions
- Summary of field studies conducted

Ecological Effects Assessment

- Summary of toxicity tests/field studies used to evaluate adverse ecological effects
- Description of the assessment and measurement endpoints

Ecological Risk Characterization

This section provides a summary of environmental risks associated with relevant media, the basis of these risks, how risks were determined, and COC concentrations expected to be protective of ecological receptors.

Summary of the Fate and Transport Analysis

The results of the fate and transport analysis with emphasis on where the remedial action is required is summarized in this section.

Discussion of Principal Threat Source Material

This section identifies if source material exists at the OU that exceeds principal threat source material (PTSM) levels and its location.

Conclusions

This section summarizes the results of the human health and ecological risk assessments, contaminant migration assessment, and PTSM evaluation. The section may be organized by subunit, when applicable. Remedial action is generally warranted if one or more of the following conditions is met: (1) the cumulative excess carcinogenic risk to an individual exceeds the acceptable risk for the current or future land use; (2) the non-carcinogenic HI is greater than one for either current or future land use; (3) site-specific contaminants cause (or will cause) adverse environmental impacts; or (4) chemical-specific standards or other measures that define acceptable risk levels are exceeded.

VIII. REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

This section presents the specific remedial action objectives (RAOs) for the OU. RAOs should be specific at this point and indicate the cleanup levels to achieve. How the RAOs will address the problems warranting action is discussed, and cleanup levels for contaminated media are provided. Table format and illustrations are used as appropriate.

Remedial Action Objectives

RAOs are media- or OU-specific objectives for protecting human health and the environment. RAOs usually specify potential receptors and exposure pathways, and are identified during project scoping once the CSM is understood. RAOs describe what the remediation must accomplish and are used as a framework for developing remedial alternatives. The RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. This section presents a list of the RAOs in bullet format just as presented in the SB/PP or PP for the OU and by subunit if appropriate.

Cleanup Levels

This section presents the range of preliminary remedial goals (PRGs) for each COC and are typically identified along with the RAOs. Following public comment and approval of the SB/PP or PP document, the final cleanup levels for the selected remedy are chosen from the range of PRGs and documented in the ROD. PRGs and final cleanup levels for receptors and media of concern are presented in a table and referenced in this section.[1]

Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA, as amended by the Superfund Amendments Reauthorization Act (SARA), requires that remedial actions for cleanup of hazardous substances must comply with requirements and standards set forth under federal and state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs). ARARs include only federal or state environmental or facility laws and regulations and do not include occupational safety or worker protection requirements. SARA requires that the remedial action for an OU meet all ARARs unless a waiver is invoked.

This section provides a description of the three ARAR categories (action-specific, location-specific, and chemical-specific) and references the table that identifies the ARARs for the selected remedy. Key ARARs associated with each alternative are discussed in more detail in the

[1] Preliminary Remedial Goals (PRGs) were formerly known as Remedial Goal Options (RGOs) and Cleanup Levels were formerly known as Remedial Goals (RGs) in pre-2021 SRS regulatory documents. The RGO and RG terms are now obsolete.

Description of Alternatives section. This section may also identify "to-be-considered" advisories, criteria, or guidance, including USDOE Orders.

IX. DESCRIPTION OF ALTERNATIVES

The objective of this section is to provide a brief understanding of the remedial alternatives developed for the OU. A minimum of 3 remedial alternatives are evaluated unless the USEPA and SCDHEC agree to an OU-specific exemption. For example, if a No Action Alternative and a LUC Alternative are under consideration, a third alternative that reduces the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants may also be included.

Remedy Components, Common Elements, and Distinguishing Features of Each Alternative

A brief description of the remedy and bulleted list of the major remedy components of each remedial alternative evaluated is presented as they logically occur in the remediation process. A summary of the cost (capital costs, operations and maintenance [O&M] costs, total present-worth cost) is presented for each remedial alternative.

A description of the common elements and distinguishing features unique to each remedial alternative is provided. Examples of common elements and features include the following:

- Treatment technologies, the materials the treatment will address (e.g., PTSM), and how treatment will reduce the threat posed by the contamination
- Containment components of the remedy (e.g., engineering controls, cap, hydraulic barriers, etc.), and the materials they will address (e.g., treatment residuals)
- LUCs (Institutional Controls and Engineering Controls), the entity responsible for implementing, monitoring, reporting the LUCs (typically USDOE), and a reference to the LUCIP implementation details. LUCs should be descriptive and specific for the remedy.
- Monitoring requirements and monitoring frequency

- O&M activities required to maintain the integrity of the remedy (e.g., cap maintenance)
- Key ARARs associated with each remedial alternative evaluated are identified (i.e., those ARARs that would be different between alternatives and are the basis for developing the alternative). ARARs for the selected remedy are included in table format and referenced in this section.
- Long-term reliability of the remedy (potential for remedy failure/replacement costs)
- Quantity of untreated waste and treatment residuals to be disposed off-site or managed on-site in a containment system and degree of hazard remaining in such waste
- Available land use upon achieving cleanup levels and timeframe (e.g., industrial use available in three years when cleanup levels are achieved)
- Available groundwater use upon achieving cleanup levels and timeframe
- Other impacts or benefits associated with each alternative

For an interim action, this section will describe the limited alternatives (including the No Action alternative) that were considered for the interim action (generally three or fewer). Only those requirements that are ARARs for the limited-scope interim action are incorporated into the description of alternatives.

X. COMPARATIVE ANALYSIS OF ALTERNATIVES

This section provides a brief comparison of the relative performance of each alternative against the others with respect to the nine CERCLA evaluation criteria. A summary table may be added in addition to the discussion in the text.

The nine CERCLA evaluation criteria include the following:

- Overall protection of human health and the environment (“industrial” or “residential” is specified to qualify the protectiveness statements).
- Compliance with ARARs

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

For an interim action, this section is presented in light of the limited scope of the action. Evaluation criteria not relevant to evaluation of interim actions are not addressed in detail. Rather, their irrelevance to the decision is briefly noted.

XI. THE SELECTED REMEDY

Detailed Description of the Selected Remedy

This section expands on the description of the selected remedy from that which was provided in the Description of Alternatives section. A clear, concise, thorough explanation of the logic behind selecting the alternative is provided. This will include a summary of the major distinguishing features for the selected remedy over each of the other alternatives. A reference to a CSM that illustrates how the primary exposure routes of concern are broken/rendered incomplete following implementation of the selected remedy is also provided.

A statement that the remedy may change as a result of the remedial design or construction processes is included. Changes to the remedy described in the ROD will be documented in the ARF utilizing a memo, an Explanation of Significant Difference (ESD), or ROD Amendment.

If a selected alternative is and/or includes LUCs, the appropriate LUC objectives are provided from the list below to ensure protectiveness of the selected remedy. OU-specific objectives may also be added as appropriate.

- Prevent contact, removal, or excavation of [media or components for OU are listed, e.g., contaminated soil and pipelines, buried waste, etc.].
- Prohibit the development and use of property for residential housing, elementary and secondary schools, childcare facilities and playgrounds.
- Maintain the integrity of any current or future remedial or monitoring system, such as soil vapor extraction systems, soil covers, or groundwater monitoring wells.
- Prevent access or use of contaminated groundwater until cleanup levels are met.
- Prevent construction of inhabitable buildings above volatile organic compound plumes without an evaluation of indoor air quality to address vapor intrusion.

If a selected alternative is and/or includes LUCs, the LUCs for the OU (i.e., signage at the OU boundaries, maintenance of a soil cover, plugging and grouting of manholes and pipelines, etc.) are described. A table is referenced that includes the type of control, purposes of control, duration, implementation (including when it will be implemented) and affected areas. Language consistent with the text shown below is used in ROD documents.

"LUCs for the [OU name] are presented in Table [X] and include the following:

- *[OU specific controls are listed]*
- *Signage will be located at the [OU name] boundaries shown in Figure [X] to alert on-site workers to the presence of hazardous substances and to prevent unauthorized entry and unrestricted uses. The date for installation of the signs will be stated in the OU-specific LUCIP referenced in this ROD.*
- *Institutional controls (i.e., administrative measures) and use restrictions for on-site workers via the SRS Site Use/Site Clearance Program. Other administrative controls to ensure worker safety include work controls, worker training, and worker briefings of health and safety requirements*.

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

For remedies that include institutional controls (i.e., a type of administrative LUC), the following language is included in the ROD.

"In the long term, if the property, or any portion thereof, is ever transferred from USDOE, the U.S. Government and/or USDOE will take those actions necessary pursuant to Section 120(h)(1) of CERCLA. Those actions will include in any contract, deed, or other transfer document, notice of the type and quantity of any hazardous substances that were known to have been stored (for more than one year), released, or disposed of on the property. The notice will also include the time at which the storage, release, or disposal took place to the extent such information is available.

In addition, if the property, or any portion thereof, is ever transferred by deed, the U.S. Government will also satisfy the requirements of CERCLA 120(h)(3). The requirements include: a description of the remedial action taken, a covenant, and an access clause. These requirements are also consistent with the intent of the RCRA deed notification requirements at final closure of a RCRA facility if contamination will remain at the OU.

LUCs will be implemented through the following:

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

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

In the event of a property lease or interagency agreement, the equivalent restrictions will be implemented as required by CERCLA Section 120(h).

The selected remedy for the [OU name] leaves hazardous substances in place that pose a potential future risk and will require land use restrictions for as long as necessary to keep the selected remedy fully protective of human health and the environment. As agreed on March 30, 2000, among the USDOE, USEPA, and SCDHEC, SRS is implementing a Land Use Control Assurance Plan (LUCAP) [reference] to ensure that the LUCs required by numerous remedial decisions at SRS are properly maintained and periodically verified. The OU-specific LUCIP referenced in this ROD will provide details and specific measures required to implement and maintain the LUCs selected as part of this remedy. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs selected under this ROD. The LUCIP, developed as part of this action, will be submitted concurrently with the CMIP/RAIP [or RAIP if CERCLA only], as required in the FFA for review and approval by USEPA and SCDHEC. Upon final approval, the LUCIP will be appended to the LUCAP and is considered incorporated by reference into the ROD, establishing LUC implementation and maintenance requirements enforceable under CERCLA and the SRS FFA. The approved LUCIP will establish implementation, monitoring, maintenance, reporting, and enforcement requirements for the OU. The LUCIP will remain in effect unless and until modifications are approved as needed to be protective of human health and the environment. The LUCs shall be maintained until the concentration of hazardous substances associated with the OU have been reduced to levels that allow for unlimited exposure and unrestricted use. Approval by USEPA and SCDHEC is required for any modification or termination of the OU-specific LUCs.

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

Cost Estimate for the Selected Remedy

This section presents the estimated costs associated with implementing and maintaining the selected remedy. The cost estimate includes estimated capital costs, O&M costs, and present worth costs, and the estimated number of years for completion of the remedy. The text will reference a cost estimate summary table.

The following Cost Estimate Disclaimer is included:

"The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the ARF, an ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost."

Estimated Outcomes of Selected Remedy

This section provides a brief description of the estimated outcome of the selected remedy based on elements relevant to the OU including the following:

- Available land use upon achieving cleanup levels (e.g., industrial use available in three years when cleanup levels are achieved).
- Available groundwater use upon achieving cleanup levels.

- Final contaminant specific cleanup levels for each media, basis for cleanup levels, and any remaining risk at cleanup levels (if appropriate).
- Anticipated environmental and ecological benefits (e.g., restoration of sensitive ecosystems, protection of endangered species, protection of wildlife populations, wetlands restoration).

Waste Disposal and Transport

This section includes a discussion of any waste management procedures including management of environmental sampling, handling of decontamination solutions, management of debris, etc. as appropriate for the OU.

If the OU has been identified in previous documents as being a RCRA listed waste site, the following language is included:

> *"Environmental media that contain RCRA listed waste are subject to applicable RCRA requirements until determined to no longer contain hazardous waste. Environmental media and/or secondary waste will be determined to no longer contain listed hazardous waste by direct comparison to the Health Based Levels (HBLs) for soil and groundwater. The HBLs for soil are based on the lower of (1) the USEPA Regional Screening Levels for the residential exposure scenario or (2) the RCRA toxicity characteristic level (due to the 20-fold dilution factor inherent in the toxicity characteristic leaching procedure [TCLP] analysis of solids, the RCRA TCLP values are multiplied by 20). Due to the analytical method limitations, groundwater (as defined by South Carolina Regulation 61-68) HBLs are based on the higher of (1) MCLs, or (2) USEPA RCRA (SW-846) analytical minimum detection levels (MDLs)."*

XII. STATUTORY DETERMINATIONS

This section should coincide with the Statutory Determination section of the Declaration and provide a confirmatory statement that the selected remedy satisfies the statutory requirements of CERCLA. Language consistent with the text shown below is used as appropriate for the OU.

For No Action remedies, the following language is used:

"Based on the OU [RFI/RI/BRA or RI/BRA of CERCLA-only OU) report, the [OU name] does not pose a threat to human health and the environment. No Action has been selected as the remedy, and the future land use of the [OU name] will be unrestricted. Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for this remedial action."

For remedies that are not No Action, the following language is used:

"Based on the OU [RFI/RI/BRA or RI/BRA of CERCLA-only OU) report, the [OU name] poses a threat to human health and the environment. Therefore, [selected remedial alternative title], has been selected as the remedy for the [OU name]. As part of the selected remedy, the future land use of the [OU name] will be [industrial or other non-residential use]."

The following language for remedial actions requiring 5-year remedy review is included:

"In accordance with Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(c), a statutory review will be conducted within five years of initiation of the remedial action, and every five years thereafter, to ensure that the remedy continues to be protective of human health and the environment."

An explanation is provided on how the selected remedy satisfies the requirements of Section 121 of CERCLA (as appropriate) to be protective of human health and the environment, compliant with key ARARs (unless justified by a waiver), cost-effective, utilize permanent solutions and alternative treatment (resource recovery) technologies to the maximum extent practicable, demonstrate a preference for treatment as a principal element (or justifies not meeting this preference), and is subject to five-year remedy reviews.

For an interim action, this section will address only those ARARs specific for the interim action (e.g., residual management during implementation). The discussion under "utilization of permanent solutions and treatment to the maximum extent practicable" should indicate that the interim action is not designed or expected to be final, but that the selected interim remedy represents the best balance of trade-offs among the alternatives with respect to pertinent criteria, given the limited scope of the action. The discussion under the "preference of treatment" section should note that the preference will be addressed in the final decision document for the site or final OU, although treatment components "that support the preference" should be noted.

XIII. EXPLANATION OF SIGNIFICANT CHANGES

This section identifies if there have been any significant changes in the selected remedy from the preferred alternative identified in the SB/PP or PP document. If no significant changes have occurred, the following text is provided in this section.

"The remedy/remedies selected in this ROD do not contain any significant changes from the preferred alternative(s) presented in the SB/PP [or PP]. No comments were received during the public comment period" or "Comments received during the public comment period did not materially alter the selected remedy."

If there are significant changes in the selected remedy from the preferred alternative identified in the SB/PP or PP, the following is provided in this section.

- Discussion of the preferred alternative originally presented in the SB/PP or PP.
- Description of the significant changes in the selected remedy.
- Explanation of the rationale for the changes and how they could have been reasonably anticipated based on the information presented in the SB/PP or PP.

XIV. RESPONSIVENESS SUMMARY

The Responsiveness Summary serves the dual purposes of (1) presenting stakeholder concerns about the OU and preferences regarding the remedial alternatives, and (2) explaining how those concerns were addressed and how the preferences were factored into the remedy selection process. This discussion will cross-reference sections of the Decision Summary that demonstrate how issues raised by the community have been addressed. SRS CAB recommendations or comments made during the public comment period are summarized and responded to in the Responsiveness Summary.

This section will include the following statement:

"The Responsiveness Summary is included as Appendix A of this document."

XV. POST-ROD DOCUMENT SCHEDULE AND DESCRIPTION

This section identifies the major post-ROD submittals and dates in bullet format.

For a final ROD, this section will include explicit statements telling the reader when cleanup will start in the field and when cleanup is scheduled for completion.

For an IROD, this section will include explicit statements telling the reader when cleanup will start in the field, when cleanup is scheduled for completion, any needed statements about a final CMS/FS for the proposed final remedy for the OU, a statement identifying the timing of the public comment period for the final SB/PP or PP, and when the final ROD is scheduled for approval.

XVI. REFERENCES

This section provides a list of the documents that are referred to in the ROD and may include the following reference.[2]

[2] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents, OSWER Directive 9200.1-23P, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., July 1999.

Figures and Tables

A sample of figures and tables that may be included in the ROD are listed below. Figures and tables may also be presented in appendices. Figures and tables are specific for the OU.

Figure 1. Location of the OU within the SRS
Figure 2. Layout of the OU
Figure 3. Location of the OU within the Integrator Operable Unit Watershed
Figure 4. Photograph of OU
Figure 5. Location of OU Subunits
Figure 6. Sample Locations or Monitoring Well Locations
Figure 7. Schematic Cross Section of the OU
Figure 8. Land Use Map for the OU
Figure 9. CSM Following Implementation of the Selected Remedy

Table 1. Summary of Constituents of Concern and Medium-Specific Exposure Point Concentrations
Table 2. Cancer Toxicity Data Summary
Table 3. Non-Cancer Toxicity Data Summary
Table 4. Risk Characterization Summary – Carcinogens
Table 5. Risk Characterization Summary – Non-Carcinogens
Table 6. Ecological Exposure Pathways of Concern
Table 7. COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors
Table 8. Summary of Final Cleanup Levels
Table 9. Description of CERCLA Evaluation Criteria
Table 10. Summary of the Comparative Analysis of the Alternatives
Table 11 ARARs for the Selected Remedial Alternative
Table 12. Cost Estimate for the Selected Remedy
Table 13. Land Use Controls for the OU

List of Appendices

This section identifies the appendices included in the ROD. Appendices are specific for the OU and at a minimum, include Appendix A for the Responsiveness Summary.

This page is intentionally left blank.

LAND USE CONTROL IMPLEMENTATION PLAN FORMAT

1.0 INTRODUCTION

This purpose of this section is to introduce the Land Use Control Implementation Plan (LUCIP) to describe the land use controls (LUCs) selected in the Operable Unit (OU)-specific Record of Decision (ROD). The Introduction section includes a brief summary of the OU characteristics (i.e., size, subunits, media, etc.) with direction to Section 3.0 for a list of the LUC objectives.

The following language is included in the Introduction section consistent with the ROD:

"*The selected remedy leaves hazardous substances in place that pose a potential future risk and will require land use restrictions until the concentrations of hazardous substances in the soil and groundwater are at levels that allow for unrestricted use. As agreed on March 30, 2000, among the United States Department of Energy (USDOE), the United States Environmental Protection Agency (USEPA), and the South Carolina Department of Health and Environmental Control (SCDHEC), Savannah River Site (SRS) is implementing a Land Use Control Assurance Plan (LUCAP) [reference] to ensure that the land use controls (LUCs) required by numerous remedial decisions at SRS are properly maintained and periodically verified. The requirements of the LUCAP also apply to the LUCs that were selected as part of the remedial action (RA) for [operable unit (OU) name]. This additional document, the [OU name] Land Use Control Implementation Plan (LUCIP), contains the detailed and specific measures required to implement and maintain the LUCs selected as part of this particular remedial decision. The LUCs shall be maintained until the OU is suitable for unlimited exposure and unrestricted use. Approval by USEPA and SCDHEC is required for any modification or termination of the LUCs.*

USDOE is responsible for implementing, maintaining, monitoring, reporting, and enforcing the LUCs in accordance with the approved LUCIP. Upon final approval, the LUCIP will be appended to the LUCAP and should be considered incorporated by reference into the [OU name] Record of Decision (ROD), establishing implementation and maintenance requirements for the LUCs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the SRS Federal Facility Agreement (FFA) [reference]. The LUCIP will remain in effect unless and

until modifications are approved by USEPA and SCDHEC as necessary for protection of human health and the environment. In accordance with Section 121(c) of CERCLA and National Oil and Hazardous Substances Pollution Contingency Plan (referred to as the National Contingency Plan [NCP]) §300.430(f)(5)(iii)(c), a statutory review will be conducted within five years of initiation of the RA, and every five years thereafter, to ensure that the remedy continues to be protective of human health and the environment. Any approved LUCIP modification will be appropriately documented for incorporation by reference into the [OU name] ROD."

2.0 OVERVIEW OF OU REMEDIAL ACTION

2.1 General Description and History of the OU

This section briefly describes the OU. The description should include the location, size (acreage), and summary of the operational history. A discussion of subunits and environmental media within the OU should be included if appropriate. The text will reference figures (e.g., location maps, OU subunit map, etc.) as appropriate.

2.2 Nature and Extent of Contamination in the OU

This section identifies the specific constituents of concern for remedial action (RA) and the associated residual risks for each medium included in the OU. Discussion is included in the text to relate the residual risk to the need for implementing and maintaining LUCs as an integral part of the RA selected in the ROD. Language consistent with the following is included in this section:

"*The selected remedy for the [OU name] leaves hazardous substances in place that pose a potential future risk and will require land use restrictions until the concentrations of hazardous substances in the soil and groundwater are at levels that allow for unrestricted use and exposure*."

2.3 Remedial Action Selected

This section briefly states the selected remedy. The ROD selecting the RA is identified, and a brief summary of the RA and LUC elements of the action is included. The section should also discuss any removal actions, interim or early remedial actions, and/or RA decisions and how this impacts the LUCs (i.e., cap installed as an early action requires LUCs beyond the early action and long-term maintenance).

The text will reference the post-RA conceptual site model that demonstrates that the exposure pathways for the industrial worker are incomplete following implementation of the RA. The following statement is included:

"*According to the Savannah River Site Future Use Project Report [reference], residential use of SRS land is prohibited.*"

3.0 LAND USE CONTROL OBJECTIVES

This section lists the LUC objectives for the OU necessary to ensure protectiveness of the selected remedy. Each LUC objective should be related to one or more of the remedial action objectives that it is expected to help achieve. The LUC objectives are consistent with the list of objectives documented in the OU-specific ROD.

Current access controls and land transfer requirements needed to maintain the future land use are described in the following sections of the LUCIP.

4.0 IMPLEMENTATION OF LAND USE CONTROLS

This section provides specific details about how the LUCs will be implemented and maintained. The subsections below provide more detail and address subjects relevant to implementing and maintaining the LUCs. The information in Section 4.0 is also summarized in a table.

At a minimum, text similar to the following is included in Section 4.0:

"*This section describes the LUCs selected in the ROD to achieve the LUC objectives stated in Section 3.0. A summary of the types of LUCs is provided in Table [X]. USDOE is responsible for implementing, maintaining, reporting on, and enforcing the LUCs required for the [OU name]. The LUCIP will become enforceable and will be implemented when approved by USEPA and SCDHEC following the completion of the RAs prescribed by the [OU name] ROD. USDOE shall notify USEPA and SCDHEC 60 days in advance of any proposed land use changes that are inconsistent with the LUC objectives or selected remedy.*

The [OU name] will be maintained as an industrial (or other non-residential) use area by implementation of the property record notices and restrictions (Section 4.1) and the LUC boundary map (Section 4.2).

The SRS Site Use Program (Section 4.3) will be implemented to prevent onsite worker exposure to contamination left in place at the [OU name]. Other existing measures (i.e., SRS Site Clearance Program, worker training, health and safety requirements, work controls) will also be used to ensure worker safety at the [OU name]. Physical access controls (Section 4.4) are implemented at the SRS boundary to control and restrict public and trespasser access to the [OU name].

Signs at the [OU name] will be maintained to alert onsite workers to the presence of hazardous substances. The signs will also convey the restrictions of unauthorized personnel. Access control warning signs will be placed and maintained around the [OU name] [and/or at access roads to the OU] to prevent unknowing entry and unrestricted use."

4.1 Property Record Notices and Restrictions

This section describes the requirements for the administrative LUCs and transfer of property. Language consistent with the following is included in this section:

"*In the long term, if the property, or any portion thereof, is ever transferred from USDOE, the U.S. Government and/or USDOE will take those actions necessary pursuant to Section 120(h)(1) of the CERCLA. Those actions will include in any contract, deed, or other transfer document, notice of the type and quantity of any hazardous substances that were known to have been stored (for more than one year), released, or disposed of on the property. The notice will also include the time at which the storage, release, or disposal took place to the extent such information is available.*

In addition, if the property, or any portion thereof, is ever transferred by deed, the U.S. Government will also satisfy the requirements of CERCLA 120(h)(3). The requirements include a description of the RA taken, a covenant, and an access clause. These requirements are also consistent with the intent of the Resource Conservation and Recovery Act (RCRA) deed notification requirements at final closure of a RCRA facility if contamination will remain at the OU.

LUCs will be implemented through the following:

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

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

In the event of a property lease or interagency agreement, the equivalent restrictions will be implemented as required by CERCLA Section 120(h).

USDOE shall provide USEPA and SCDHEC notice at least six months prior to transfer or sale of property subject to LUCs so that USEPA and SCDHEC can be involved in discussions to ensure that appropriate provisions are included in the transfer documents to maintain effective LUCs. If it is not possible for USDOE to notify USEPA and SCDHEC at least six months prior to the transfer or sale, then the facility will notify USEPA and SCDHEC as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to LUCs. In addition to the land transfer notice and discussion provisions above, USDOE further agrees to provide USEPA and SCDHEC with similar notice within the same time frames as to federal-to-federal transfer of property."

4.2 LUC Boundary Maps

This section discusses the LUC boundary maps for the proposed area under land use restrictions. The most current LUC figure or design sketch with boundary coordinates (if available) is provided. Following field implementation of the RA, a final (as-built) survey is developed to include the boundary coordinates for the area subject to land use restrictions and general locations of access control warning signs. The final as-built survey will be submitted to USEPA and SCDHEC in the

Post-Construction Report (PCR) [or PCR/Corrective Measures Implementation Report/Remedial Action Completion Report (PCR/CMIR/RACR)].

If there is a groundwater component in the OU, the LUC map will identify the surface area subject to LUCs and depict the current estimated location of the groundwater plume subject to LUCs. The figure is included in the PCR [or PCR/CMIR/RACR] depicting the estimated groundwater plume location under LUCs.

In addition, if the OU is ever transferred to non-federal ownership, a certified survey plat of the OU will be prepared at or near the time of conveyance to support the LUCIP required restrictive covenants on land use and will be recorded with the appropriate county recording agency.

4.3 Site Use Program

This section provides a description of the SRS Site Use Program and the Site Clearance Program as it relates to the OU-specific LUCs. If LUCs are required for an FFA OU, the OU-specific LUC boundaries are identified on the SRS site development maps. The SRS Site Development Control (SDC) must verify that any proposed work to be performed on an FFA OU is sanctioned by a Site Use Permit and verify that the proposed activity does not conflict with any previously approved land use.

The SDC also administers the Site Clearance Program to control the construction, alteration, or demolition activities at SRS. Before any work that adds or modifies features or facilities portrayed on the SRS site development maps is conducted, a Site Clearance Permit is required. All employees, contractors, and visitors at SRS are required to adhere to the Site Use Program and the Site Clearance Program.

Approval by USEPA and SCDHEC is required for any modification or termination of the LUCs and implementation actions, and USDOE must obtain prior approval from USEPA and SCDHEC before taking any anticipated action that may disrupt the effectiveness of the LUCs or alter or negate the need for LUCs.

4.4 Physical Access Controls

This section describes the implementation and maintenance of physical access controls (e.g., fences, gates, barriers). The text will identify when the physical controls will be first implemented, what steps will be taken to put the LUCs in place, the entity responsible for each required activity where appropriate, what portion(s) of the overall OU will be subject to LUCs, and how effectiveness of the LUC will be monitored and maintained.

If physical access controls are not required at the OU, the following paragraph is included to recognize access controls at the SRS boundary.

"*There are no physical access controls required at the [OU name]; however, physical access controls are provided at the SRS boundary as mentioned in Table [X]*."

4.5 Warning Signs

This section describes the implementation and maintenance of access control warning signs at the OU. Language consistent with the following is included in this section:

"To prevent unknowing entry and to ensure that unrestricted use of the OU does not occur while the OU is under ownership of USDOE, access control warning signs, as shown in Appendix [X], will be posted at the OU. Installation of the access control warning signs will follow the [OU name] construction schedule as described in the Corrective Measures Implementation Plan/Remedial Action Implementation Plan (CMI/RAIP) and will be completed by [date]. In addition, the final placement of the signage will be documented in the PCR [or PCR/CMIR/RACR]. The signs will be legible for a distance of at least 7.62 meters (25 feet).

Custodial responsibilities for maintenance and inspection of the [OU name] will be maintained by the SRS Post-Closure Maintenance Group."

4.6 Other Access Controls and Security/Surveillance Measures

This section describes other access controls and security or surveillance measures that are maintained in accordance with the current Resource Conservation and Recovery Act (RCRA) Permit Renewal Application, Volume I, Section F.1. This section describes the 24-hour

surveillance system (R.61-79.264.14(b)(1)), artificial or natural barriers (R.61-79.264.14(b)(2)(i), control entry systems (R.61-79.264.14(b)(2)(ii)), and access control warning signs (R.61-79.264.14(c)) in place at the SRS boundary to comply with the security requirements for a RCRA-permitted facility.

4.7 Field Inspection and Maintenance for Land Use Controls

This section describes the maintenance and inspection used to enforce the LUCs at the OU including the frequency of inspections. Inspections are performed per the Field Inspection Checklist included as an appendix. Language consistent with the following is included in this section:

"*Any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs will be addressed by USDOE as soon as practicable, but in no case will the process be initiated later than 10 days after USDOE becomes aware of the breach. USDOE will notify USEPA and SCDHEC as soon as practicable but no longer than ten days after discovery of any activity that is inconsistent with the LUC objectives or use restrictions, or any other action that may interfere with the effectiveness of the LUCs. USDOE will notify USEPA and SCDHEC regarding how USDOE has addressed or will address the breach within ten days of sending USEPA and SCDHEC notification of the breach.*

The FFA Annual Progress Report, submitted to the regulatory agencies by USDOE, will provide the status of the LUCs and describe how any LUC deficiencies or inconsistent uses have been addressed. In the event of property transfer or lease, the Annual Progress Report will cite findings on the following: whether the use restrictions and controls referenced above were communicated in the deed(s) or lease restrictions; whether property use conforms with the deed or lease restrictions and controls; and whether the owners and state/local agencies have been notified regarding the deed or lease restrictions and controls.

All other routine maintenance activities will be documented and maintained in files subject to USEPA and SCDHEC review and audit. A copy of the completed inspection form is maintained in the SRS Environmental Compliance & Area Completion Projects (EC&ACP) Records Management. The LUCs shall be maintained until the concentration of hazardous substances

associated with the OU have been reduced to levels that allow for unlimited exposure and unrestricted use.

Waste unit inspectors are trained in Hazardous Waste Operations and Emergency Response, RCRA Well Inspections (EC&ACP-specific training), EC&ACP RCRA Waste Unit Inspections, Radiological Worker Training, etc., as applicable for the specific inspection. Inspectors will also be trained based on the individual requirements of the regulatory approved closure documents for each OU. In addition, the inspectors are to attend yearly refresher courses. Over the years, different personnel may conduct the inspections and maintenance activities.

This OU-specific LUCIP, including the inspection checklist (Appendix [X]), will be appended to the SRS LUCAP upon final regulatory approval. After completion of the PCR [or PCR/CMIR/RACR], the preliminary inspection checklist in the LUCAP will be replaced with the final approved checklist."

5.0 REFERENCES

This section provides a list of the documents that are referred to in the LUCIP and may include the following reference document[1].

Assuring Land Use Controls at Federal Facilities, EPA Region IV Policy, U.S. Environmental Protection Agency, Region 4, Federal Facilities Branch, Atlanta GA, April 1998.

Figures and Tables

A sample of figures and tables that may be included in the LUCIP are listed below. Figures and tables will be specific for the OU. Figures and tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location of the OU Within the Savannah River Site
Figure 2. Location of the OU Subunits
Figure 3. Post-Remedial Action Conceptual Site Model for the OU
Figure 4. Land Use Control Boundary for the OU

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

Table 1. Land Use Controls for the OU

List of Appendices

Appendices are included as appropriate. LUCIP appendices are specific for the OU but include the following as a minimum.

Appendix A Access Control Warning Signs
Appendix B Field Inspection Checklist

CORRECTIVE MEASURES IMPLEMENTATION PLAN / REMEDIAL ACTION IMPLEMENTATION PLAN FORMAT

1.0 GENERAL DESCRIPTION

1.1 Purpose and Scope

The purpose of this section is to describe the plan for implementing the remedial action (RA) that was selected in the Record of Decision (ROD). Items that are addressed in the Corrective Measures Implementation Plan (CMIP)/Remedial Action Implementation Plan (RAIP) include the following:

- A general description of the location and history of the site, description of the constituents of concern (COC) considered for RA, and an overview of the selected RA
- A summary of any associated study (if applicable) and the application of its results in the remedial design
- An outline of the necessary design tasks
- A design summary highlighting the results of each of the design tasks performed to accomplish the objectives of the selected RA
- A summary of the construction strategy addressing critical components of construction activities required to implement the remedial design
- Requirements for health and safety, waste management, contamination control, decontamination, quality assurance, quality control inspections, performance verifications (sampling, testing/analysis, when applicable), post-construction operations, maintenance and land use, project closeout, post-construction monitoring and a forecast schedule for implementation of the RA
- A forecast schedule and brief discussion of the contents of the upcoming post-ROD documents required by the Federal Facility Agreement (FFA) for the Savannah River Site (SRS)

1.2 General Description and History of the Operable Unit

The general description includes the location, size, background operational history of the operable unit (OU), and environmental media affected/included. The section may also include a short paragraph identifying the predecessor documents related to the selection of the RA. Figures showing the RA location at SRS and a RA site layout are provided. A very condensed presentation of information is provided in this section since the same information has been covered in greater detail in previous documents required by the FFA process.

1.3 Nature and Extent of Contamination

This section briefly describes the COCs (table may be used) identified in the ROD that are considered for RA, and the associated risks, specific components of the unit requiring remediation and locations of COCs with respect to the zone of remediation (areas and depths). Because the information is covered in greater detail in previous FFA documents, a condensed presentation (synopsis or summary) is provided in this section. Figures or maps to illustrate the nature and horizontal and vertical extent of COCs within the respective media of concern and area(s) targeted for the RA are provided. A description of any key site-specific factors is also included if applicable.

1.4 Remedial Action

The RA description is provided in this section. The discussion will also include the rationale (e.g., brief explanation of the relationship between RAs and remedial action objectives [RAOs], industrial land use, or ecological concern) for selection of the RA objectives and cleanup levels.

A conceptual site model (CSM) to illustrate how implementation of the RA breaks the exposure pathways is provided.

1.5 Remedial Action Objectives

A brief description of the RAOs for the OU and how they mitigate site risks (e.g., prevent contamination from reaching the groundwater by treating the contaminated soils, etc.) is provided. The future land use (i.e., industrial, unrestricted, etc.) is identified with a description of how the RAOs support the future land use. The RAOs are listed in bullet form and by subunit if appropriate.

1.6 Remedial Action Implementation Schedule

The RA implementation schedule is provided in this section. Typically, a reference to a figure or table with the schedule is sufficient.

1.7 Community Relations

The purpose of this section is to provide a brief summary of public involvement activities related to the OU, including applicable resolutions of public comments by appropriate references to the sections in the ROD. A very condensed presentation of information is included in this section because this information is presented in greater detail in previous documents required by the FFA process.

In addition, this section includes any OU-specific item that was identified for the resolution of public comments, related to the selected RA. In accordance with USEPA's "Superfund Community Handbook" (#EPA 540-K-05-003, April 2005), upon completion of the final engineering design, the agency must issue a "FACT SHEET" and provide a public briefing, as appropriate, prior to beginning remedial action. A RA fact sheet is attached to inform interested parties about activities related to the RA and that an opportunity for a public briefing will be held before initiation of the RA.

2.0 REMEDIAL DESIGN

2.1 Design Strategy

The purpose of this section is to provide a brief description of the remedial design strategy (e.g., identification of definitive design, performance-based design, vendor supplied design, multi-phased design, etc.).

2.2 Design Activities

A list of design tasks, including development of the permit applications required to implement the selected RA is provided. Any design activity that was performed to complete the definitive design, e.g., treatability studies, bench-scale grout mix design, etc., is also described.

2.3 Design Deliverable

A list of the design deliverables for the RA is included in this section. Design drawings, design technical information, permit documents, applicable sampling, analysis, and test plans, etc., which are necessary to verify that the RA objectives have been met are included as applicable.

2.4 Results of Data Acquisition

2.4.1 Evaluation of Studies

A summary level description of any study performed, including the application of the results and conclusion from the study to the remedial design, is provided.

2.4.2 Other Design Data

Results of any data gathered to support the remedial design (e.g., sampling, topographic, or other surveys) are provided.

2.5 Design Criteria

Functional requirements and design criteria based on United States Department of Energy (USDOE) Orders, national consensus standards, SRS and regulatory requirements needed to ensure the design meets RA objectives and cleanup levels per the ROD document are provided. A table of applicable or relevant and appropriate requirements (ARARs) which includes the ARAR type, citation, status, a brief descriptive summary of what the ARAR requires, and a brief explanation for inclusion of the ARAR is also provided. The list of ARARs will include those in the ROD that are related to the selected remedy and also any additional ARARs identified during the remedial design process.

2.6 Drawings

A list and brief description of the design drawings developed during the remedial design are provided.

2.7 Design Technical Information

A summary of the construction specifications developed during the remedial design is provided.

3.0 PERMITTING REQUIREMENTS

The purpose of this section is to identify and describe all permitting activities required for the selected RA. The related schedule for each applicable regulatory permit submittal is also included. A copy of permit documents, which are approved by other departments or authorized representatives of United States Environmental Protection Agency (USEPA) or South Carolina Department of Health and Environmental Control (SCDHEC) (e.g., Stormwater Management and Sediment Reduction Plans, Monitoring Well Program Plans, Air Quality Control Permits) may be provided for reference.

4.0 CONSTRUCTION

4.1 Construction Strategy

A brief description of the construction strategy (e.g., discussion of construction in phases, construction by subcontractor, construction using new technology, etc.) for implementation of the remedial design is provided.

4.2 Construction Activities

A summary of the conceptual construction activities that are critical for implementation of the RA is provided. Unless such activities have been concurred with by the constructor, they are considered conceptual (anticipated based on past experiences) at this stage.

4.3 Remedial Design Change Control

The purpose of this section is to provide a standard procedure for documenting and reporting changes to the remedial design after the remedial design document has been approved by USEPA and SCDHEC. The following statement (or similar words with the same intent) should be included in this section.

> *"USDOE will notify USEPA and SCDHEC, within a reasonable time frame, when significant problems arise with any aspect of the Remedial Design/RA process. In particular, scheduling, budget and implementability/technical issues should be brought to*

the attention of the regulators as soon as they are identified. Notifications will follow established protocols for major and minor changes during construction."

If the change is considered major, National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Section 300.435(c)(2)(i) or (ii) will be followed for public participation requirements. Section 300.435(c)(2)(i) applies to Explanation of Significant Differences for RODs and (ii) applies to ROD amendments.

4.4 Waste Disposal and Transport

Details consistent with the OU's waste management plan that will be used for waste characterization (e.g., testing methods, location of the disposal facility is included), and transportation (contaminant limits are included) during construction, as applicable to the selected RA are provided. The status of any permit required for handling, disposing and transporting wastes is also provided.

4.5 Quality Assurance

A summary of quality assurance and quality control procedures that will be implemented to ensure successful implementation of the RA is provided. Unique or unit-specific strategies applicable to the RA are also provided.

4.6 Non-Conformances

The anticipated steps and procedures that will be used to resolve construction non-conformances with respect to the required acceptance criteria in the specifications are provided. This section also provides a description of the contingency plan to be used during this construction phase if construction activities cannot be completed as designed.

4.7 Health and Safety Plan

Health and safety requirements, consistent with SRS procedures, that will be implemented during the RA are provided. This section includes any special or unit-specific requirements for worker safety during construction. Except for OU-specific items, the following text will be included in the CMIP/RAIP.

"A Site-Specific Health and Safety Plan (HASP) will be prepared in accordance with 29 CFR, Part 1910, Section 120, Occupational Safety and Health Administration (OSHA) and will be implemented by the construction team. The HASP will be approved in accordance with SRS procedures, and a copy will be available at the jobsite at all times. A copy of the HASP will also be available in the Environmental Compliance and Area Completion Projects project file.

The plan will describe the following:

- *Dust suppression requirements related to 40 CFR 50.6 and South Carolina Regulation 61-62.6*
- *Required actions by the facility personnel in case of fires, explosions, or any unplanned releases of hazardous waste*
- *Arrangements with onsite security, fire department, medical facility, and emergency response teams to coordinate emergency services*
- *Names, addresses, and phone numbers (office and home) of all persons qualified to act as emergency coordinators*
- *Emergency equipment available at the facility*
- *Evacuation plan for facility personnel"*

5.0 POST CONSTRUCTION

5.1 Post-Construction Monitoring

The purpose of this section is to describe the long- and short-term actions required to monitor the effectiveness of the implemented RA (e.g., monitoring of groundwater affected by the remediated unit). Details including type of sampling, sampling frequency, criteria, and reporting information will be provided, as well as maps showing the location of remediation and zone of influence. In addition, a map showing the general grid coordinates of remediation actions will be provided. Also, the criteria for turnover to the next remedial phase (e.g., startup to operation phase) is discussed in this section.

5.2 Contingency Plan Implementation Strategy

Contingencies after completion of construction, including any special or unit-specific responses and actions to be taken if the implemented RA fails to perform, are provided.

5.3 Operations, Maintenance, and Land Use Control

Start-up and operational procedures for equipment and process systems required by the selected RA are provided. This section also provides maintenance and land use control (LUC) information. In addition, it includes any special or unit-specific requirements applicable to the selected RA. For RODs requiring LUCs, a Land Use Control Implementation Plan (LUCIP) will be issued.

5.4 Requirements for Project Closeout

Field data collection and performance verification requirements (including sampling, analysis, and testing plans, when applicable) and procedures to verify that the RA objectives have been met will be provided. This section also addresses updating the design documents as required for configuration management to incorporate design changes during construction.

5.5 Schedule for Federal Facility Agreement Deliverables

A submittal schedule for the next post-ROD documents [Post-Construction Report (PCR) and the Corrective Measures Implementation Report/Remedial Action Completion Report (CMIR/RACR)] required by the FFA is provided. For RAs not requiring an extended phased implementation or operational systems, the PCR and CMIR/RACR for the OU may be combined into a single document.

6.0 REFERENCES

This section provides a list of the documents that are referred to in the CMIP/RAIP and may include the following reference documents.[1]

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

Close Out Procedures for National Priorities List Sites, USEPA OLEM Directive 9320.2-23, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., June 2022.

Guidance for Management of Superfund Remedies in Post Construction, USEPA OLEM Directive 9200.3-105, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., February 2017.

Figures and Tables

A sample of the figures and tables that may be included in the CMIP/RAIP are listed below. Figures and tables may also be presented in appendices. Figures and tables will be specific for the OU.

Figure 1. Location of the OU within the Savannah River Site
Figure 2. Post-Remedial Action Conceptual Site Model
Figure 3. Post-ROD Implementation Schedule Including Design Deliverables
Figure 4. Map(s) as Referenced in the Document

Table 1. Compliance with ARARs for the Selected Remedial Action.

List of Appendices

Appendices and attachments are included as appropriate.

Appendices are tables, charts and other information that are not stand-alone documents. At a minimum, the RA Fact Sheet is included in Appendix A. The Fact Sheet will provide a brief description of the OU, the history of the OU, and a description of the RA. A description of any remaining risks associated with the OU after implementation of the remedy will be included, as well as a description of the LUCs and duration of the LUCs.

Attachments are information that was previously presented in stand-alone documents with document numbers. Examples of attachments are engineering design drawings and plans and vendor-supplied design drawings and plans that are referenced in the body of the CMIP/RAIP. Documents such as construction and fabrication documents will not be included.

This page is intentionally left blank.

POST-CONSTRUCTION REPORT FORMAT

A Post-Construction Report (PCR) is prepared for Resource Conservation Recovery Act (RCRA) and/or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) operable units (OUs) when a portion of the remedial action (RA) has been completed (i.e., RA is completed in phases with a delay between phases), but additional actions are required before the OU can be considered closed. Example scenarios include when a remedy for the surface subunit of an OU is completed but the groundwater remedy associated with the OU is incomplete, after completion of construction activities for a remediation involving operating facilities, etc. A PCR/Remedial Action Completion Report (RACR) is prepared when all portions of the RA for an OU are complete.

1.0 INTRODUCTION

1.1 Purpose and Scope

The purpose of the PCR is to document the completion of the construction of the RA for a portion of the OU. The Record of Decision (ROD) and Corrective Measures Implementation Plan (CMIP)/Remedial Action Implementation Report (RAIP), which provide the requirements of the RA, are referenced.

Future completion of the RA and other post-construction activities will be reported in the RACR in accordance with the Federal Facility Agreement (FFA) is provided.

Items that will be addressed in the PCR include:

- A brief description of the OU background including RA requirements and objectives from the ROD
- A chronology of completed events related to remediation of the OU
- A summary of construction activities performed
- Deviations from the original design per the approved CMIP/RAIP

- Performance standards and quality control inspections, including a summary of performance test results documenting verification of compliance with the acceptance criteria in the CMIP/RAIP
- Verification of construction completion
- As-built drawings
- Forecasts of post-construction activities (e.g., startup tests, operation and maintenance) per the CMIP/RAIP and the ROD (as appropriate)
- Project costs

1.2 Operable Unit Background

This section identifies if the source OU is listed as a RCRA 3004(u) Solid Waste Management Unit and/or CERCLA Unit in Appendix C of the FFA for Savannah River Site (SRS).

1.2.1 General Description and Location

This section provides a general description of the OU. Since earlier documents have provided the same information in detail, the PCR provides a brief description of the OU with emphasis on RA requirements. If the OU is represented by subunits for evaluation purposes, the subunits and associated media addressed by the RA are introduced. A location figure is included.

1.2.2 Nature and Extent of Contamination

This section briefly describes the constituents of concern (COCs) within the respective media of concern (i.e., soil, sediment, groundwater, etc.) as identified in the ROD for the RA. The associated risks, specific components of the OU requiring remediation, and locations of COCs with respect to the RA boundaries (areas and depths) are provided. Because the information is covered in greater detail in previous FFA documents, a condensed presentation (synopsis or summary) is provided in this section. Figures or maps to illustrate the nature and horizontal and vertical extent of COCs within the respective media of concern and area(s) targeted for the RA are referenced.

1.3 Remedial Action Requirements and Objectives

1.3.1 Remedial Action Objectives

This section lists the remedial action objectives (RAOs), just as stated in the ROD, for the portions of the OU addressed in the PCR. The RAOs are listed in bullet form and by subunit if appropriate. The future land use (i.e., industrial, unrestricted, etc.) is identified with a description of how the RAOs support the future land use

1.3.2 Selected Remedial Action

The specific elements of the selected RA for the OU as described in the ROD are provided in this section.

1.4 Chronology of Events

This section provides a summary of the major milestones and dates related to the RA for the OU, including the ROD signatures, (e.g., RA start/mobilization, site preparation, stabilization, soil cover installation, final inspection [regulatory walk down], etc.), any major changes from the approved CMIP/RAIP (change in technology, change in RA, etc.) where it was necessary to get regulatory approval, demobilization and final inspection of completed construction. A Chronology of Events table is referenced. For future post-construction activities (i.e., start-up, operation and/or maintenance, effectiveness monitoring activities as applicable) and the RACR, the PCR refers to the RA implementation schedule presented in Section 7.0 of the PCR.

2.0 CONSTRUCTION ACTIVITIES

The purpose of this section is to provide a summary of construction activities performed during the construction phase in accordance with the approved CMIP/RAIP. The names and roles of prime subcontractors associated with the RA in addition to a brief narrative following the sequence of activities listed in Section 1.4 are included. Any treatment process required to implement the remedial design, materials and equipment used, successes and problems encountered during construction and resolution of problems (including innovative solutions, if any), and causes for delay are discussed. Unexpected conditions encountered in the field, particularly those that affected the scope or schedule of the construction work, are described in this section.

The specific details of the OU waste management plan including a description of the waste types, waste volumes, characterization methods, (e.g., testing methods), disposal and transportation during construction, as applicable to the selected RA, are provided.

3.0 DEVIATIONS FROM ORIGINAL DESIGN

This section identifies design changes from the approved CMIP/RAIP required during construction as well as the technical basis for those changes. A discussion of all changes made during construction, regardless of whether those changes were previously communicated to South Carolina Department of Health and Environmental Control (SCDHEC) and United States Environmental Protection Agency (USEPA) is provided. The process and scope of design change notifications are discussed in the CMIP/RAIP.

A table providing a summary of all design changes, along with the basis and resolution of deviations from the original design, may be provided. Where applicable, a statement on whether the deviation still meets a performance criterion is included.

4.0 VERIFICATION SAMPLING, TESTING AND ANALYSIS, PERFORMANCE STANDARDS, AND CONSTRUCTION QUALITY CONTROL

The purpose of this section is to provide the appropriate reference to the performance requirements (acceptance criteria) as required per the CMIP/RAIP which are derived from the RAOs in the ROD for the RA and the construction quality control requirements. If applicable a brief discussion of collection of test samples, a comparison of test results with those acceptance criteria, and a description of how those criteria were met is included. Any non-conforming conditions identified during the quality control inspection and how those non-conformances were resolved to meet the specified performance criteria are discussed.

4.1 Construction and Quality Control

This section provides a summary of quality assurance and quality control procedures that were implemented to ensure successful implementation of the RA.

5.0 VERIFICATION OF CONSTRUCTION COMPLETION AND FINAL INSPECTION

5.1 Verification of Construction Completion

This section provides a discussion of how construction activities required for the RA have met the acceptance criteria established in the approved CMIP/RAIP. If applicable, a summary of the results of the analytical sampling and testing is included and the data is either included in an appendix or text will be included to indicate that the records are being maintained at SRS.

5.2 Final Inspection

The purpose of this section is to document the final walkdown inspection with participation of USEPA and SCDHEC.

6.0 AS-BUILT DRAWINGS

6.1 As-Built Drawings

This section indicates if as-built drawings are available for the project and, if so, a reference to the drawings in an appendix of this PCR is included.

6.2 Well Modifications

This section provides a summary or identifies in an appendix where reports of any well modifications (e.g., well abandonment, well extension or protection) are located.

7.0 POST-CONSTRUCTION ACTIVITIES

The purpose of this section is to provide a forecast schedule with reference to the approved CMIP/RAIP for discussion of scope and content. A reference to subsequent Post-ROD documents (e.g., CMIR/RACR or RACR) to report completion of post-construction activities required by long-term remedial actions for the final closure of the OU is provided. Such activities include (when required per the CMIP/RAIP and the OU-specific ROD) start-up testing, operations, and effectiveness monitoring reporting. Maintenance and land use controls per the Land Use Control Implementation Plan (LUCIP) will be reported during the five-year review of the remedy.

8.0 PROJECT COSTS

A table comparing the final costs of the RA activities completed in the construction phase to the original ROD cost estimate is provided in this section. Cost deviations, beyond –30% or +50%, from the ROD cost estimate are discussed.

The cost breakdown is limited to that which was presented in the ROD.

9.0 REFERENCES

This section provides a list of the documents that are referred to in the PCR and may include the following reference documents.[1]

Guidance for Management of Superfund Remedies in Post Construction, USEPA OLEM Directive 9200.3-105, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., February 2017.

Close Out Procedures for National Priorities List Sites, USEPA OLEM Directive 9320.2-23, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., June 2022.

Figures and Tables

A sample of the figures and tables that may be included in the PCR are listed below. Figures and tables will be specific for the OU. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location on SRS Map
Figure 2. OU Location/Project Boundaries
Figure 3. Nature and Horizontal and Vertical Extent of COCs
Figure 4. Photos of RA Implementation (if appropriate)

Table 1. Chronology of Events
Table 2. Summary of Design Changes
Table 3. Project Cost Comparison

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

List of Appendices

Appendices and attachments are included as appropriate.

Examples of appendices are well modification records, well abandonment reports, test results, RA start notification letters, USEPA/SCDHEC walkdown memos, etc.

Attachments are information that was previously presented in stand-alone documents with document numbers. Examples of attachments are design drawings and plans referenced in the body of the PCR.

This page is intentionally left blank.

CORRECTIVE MEASURES IMPLEMENTATION REPORT / REMEDIAL ACTION COMPLETION REPORT FORMAT

A Corrective Measures Implementation Report/ Remedial Action Completion Report (CMIR/RACR) is prepared for Resource Conservation Recovery Act (RCRA) and/or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) operable units (OUs) at the completion of the remedial action (RAs) for Operable Units (OUs) when one or more Post-Construction Report(s) (PCR) was previously generated for a portion of the OU/remedy but additional action was still to be performed. Example scenarios requiring a CMIR/RACR are for RAs that entered a period of monitored natural attenuation (MNA) or long-term operation of constructed equipment for treatment of contaminants in the source unit or groundwater or when RAs are implemented in phases. The CMIR/RACR is submitted upon completion of operation of the constructed equipment or at the completion of all RA phases, after all RAOs have been attained. The CMIR is not included in the document if the OU is CERCLA only.

1.0 GENERAL DESCRIPTION

1.1 Purpose and Scope

The purpose of the CMIR/RACR is to document the completion of the RA and provide verification that the Remedial Action Objectives (RAOs) established in the Record of Decision (ROD) have been met for the closure of the OU. A reference is made to any previously submitted PCR which summarized construction activities performed to implement the RA. Reference to the ROD and the Corrective Measures Implementation Plan/Remedial Action Implementation Report (CMIP/RAIP) as containing the requirements for the RA is included. If appropriate, a statement indicating that MNA or operation of the equipment used for treatment of contaminant in the source unit or groundwater has ceased and all RA activities for this OU are complete is included.

The final inspection of construction by U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) is referenced. A statement is included that the CMIR/RACR documents that the RAOs have been met, and no further RCRA/CERCLA response is needed to protect human health and the environment.

Items that will be addressed in the CMIR/RACR include the following:

- A brief description of the OU background, including a brief statement on RA requirements and objectives from the ROD
- A chronology of completed events related to remediation of the OU
- A summary of reference to the PCR document(s) which summarizes construction activities performed
- A summary of operations activities performed subsequent to the PCR
- Deviations from the original design of the approved CMIP/RAIP or PCR
- Maps depicting source unit and groundwater COCs both before and after the RA completion
- Performance standards and quality control (QC) inspections, including a summary of performance test results documenting verification of compliance with the acceptance criteria in the CMIP/RAIP or PCR
- Final inspection and verification of OU Closure
- As-built drawings
- Land Use Controls (LUCs), if required
- Project costs

Clarification is made that the PCR was previously submitted and not combined with the CMIR/RACR because the OU required long-term RAs, i.e., the final RA required MNA or long-term operation of constructed equipment or systems for treatment of contaminants in the source unit or in the groundwater and/or RAs were implemented in phases. The CMIR/RACR is submitted upon completion of operation of the constructed equipment, or at the completion of all phases and attainment of all RAOs.

1.2 Operable Unit Background

This section identifies if the source OU is listed as a RCRA 3004(u) Solid Waste Management

Unit and/or CERCLA Unit in Appendix C of the Federal Facility Agreement (FFA) for Savannah River Site (SRS).

Since earlier documents have provided the same information in detail, the CMIR/RACR provides a brief description of the OU with emphasis on RA requirements, including whether the OU is a RCRA and/or CERCLA unit. Predecessor documents related to the construction of the RA (e.g., PCR) are identified. Figures showing the RA location and a pre-RA site layout are included.

Previous community involvement activities are summarized. A condensed presentation of information is provided since the same information has been covered in greater detail in previous documents required by the FFA process; however, this document is supposed to be a stand-alone document presenting all aspects of the RA.

1.2.1 General Description and Location

This section provides a general description of the OU. If the OU is represented by subunits for evaluation purposes, the subunits and associated media addressed by the RA are introduced. A location figure is included.

1.2.2 Nature and Extent of Contamination

This section briefly describes the constituents of concern (COCs) within the respective media of concern (i.e., soil, sediment, groundwater, etc.) as identified in the ROD for the RA. The associated risks, specific components of the OU requiring remediation, and locations of COCs with respect to the zone of remediation (areas and depths) is provided. Because the information is covered in greater detail in previous FFA documents, a condensed presentation (synopsis or summary) is provided in this section. Figures or maps to illustrate the nature and horizontal and vertical extent of COCs within the respective media of concern and area(s) targeted for the RA are referenced.

1.3 Remedial Action Requirements and Objectives

1.3.1 Remedial Action Objectives

This section lists the RAOs for the OU just as stated in the ROD.

The RAOs are listed in bullet form and by subunit if appropriate just as they are stated in the ROD. The future land use (i.e., industrial, unrestricted, etc.) is identified with a description of how the RAOs support the future land use.

1.3.2 Selected Remedial Action

The specific elements of the RA as described in the ROD are provided in this section. The discussion will include a brief explanation of how the implementation of this RA achieves RAOs and mitigates site risks (e.g., prevent contamination from reaching the groundwater by treating the contaminated soils, etc.). A conceptual site model (CSM) to illustrate how implementation of the RA breaks the exposure pathways is provided.

1.4 Chronology of Events

This section provides the tabular summary of activities performed during the construction phase in accordance with the approved CMIP/RAIP as was presented in the PCR. A tabular summary of the additional post-PCR major milestones and dates related to the RA for the OU, PCR approval, major operations verification sampling and performance testing, inspections, identification and resolution of non-conformances (if any), demobilization and final inspection (regulatory walkdown) of completed operations is also provided.

2.0 OPERATIONS ACTIVITIES

The purpose of this section is to provide a summary of operations activities performed during the operations phase in accordance with the approved PCR. The summary will be a brief narrative following the sequence of activities listed in Section 1.4. A description of the following will also be provided:

- The materials and equipment used
- The name and roles of the prime subcontractor(s)
- Any treatment process required to implement the RA
- Operating permits

- Successes and problems encountered during operations and resolutions of problems (including innovative solutions, if any) and causes for any delay
- A brief discussion of unexpected conditions encountered in the field, particularly those that affected the scope or schedule of the operations phase of the RA

2.1 Performance Reports

The purpose of this section is to provide a brief description of any Effectiveness Monitoring Reports (EMRs), Corrective Action Plans, etc., that documents the effectiveness of the RA in meeting the performance criteria. For example, the following specific language for groundwater RAOs is included in this section if applicable:

"The effectiveness of the RA in meeting the performance criteria of the groundwater RAOs was assessed through periodic Effectiveness Monitoring Reports (EMRs), Corrective Action Plans, etc."

Discussions and graphs of operations durations, mass of materials treated, mass of COCs removed, COC concentrations in groundwater, vadose zone, and/or source units, as well as discussions of significant downtimes and mass or concentration spikes or rebounds is included. Hydrogeological conditions throughout the plume and the impact of the RAs may also be included. Implementation results along with system effectiveness in meeting the RAOs are highlighted.

2.2 Equipment Decontamination and Decommissioning

The purpose of this section is to provide a description of the decontamination and decommissioning of the treatment systems not permanently required for the RA.

2.3 Waste Disposal

The purpose of this section is to include a description of the waste types and waste volumes generated, including secondary and job-control waste, during the implementation of the RA. The transportation method and disposal location are also provided. If applicable, sampling data collected to verify disposal criteria are provided. References to SRS site procedures for applicable disposal methods are made.

3.0 DEVIATIONS FROM ORIGINAL DESIGN

This section identifies design changes from the approved CMIP/RAIP required during construction as well as the technical basis for those changes. A discussion of all changes made during construction, regardless of whether those changes were previously communicated to SCDHEC and USEPA is provided. The process and scope of design change notifications are discussed in the CMIP/RAIP.

A table providing a summary of all design changes, along with the basis and resolution of deviations from the original design, may be provided. Where applicable, a statement on whether the deviation still meets a performance criterion is included.

4.0 VERIFICATION SAMPLING, TESTING, ANALYSIS, PERFORMANCE STANDARDS, AND OPERATIONS QUALITY CONTROL

4.1 Performance Requirements/Standards

The purpose of this section is to provide a summary of the verification for each RA component that was presented in the PCR and to provide the performance requirements/acceptance criteria for the operation phases of the RA. Appropriate references to the performance requirements and the operation QC requirements as required per the PCR and/or CMIP/RAIP for the RA will be provided. A brief discussion and table of test samples, and a comparison of test results with the PCR and/or CMIP/RAIP acceptance criteria performance requirements and/or process control parameters broken down by type of media evaluated (groundwater, vadose zone, air emission, etc.) may be included as applicable. Non-conforming conditions identified during the QC inspection and how those non-conformances were resolved to meet the specified performance criteria are discussed.

4.2 Operations Quality Control

The purpose of this section is to provide a summary of operations quality assurance and QC procedures that were implemented to ensure successful implementation of the RA.

5.0 VERIFICATION OF RA COMPLETION AND FINAL INSPECTION

If the OU is being released for unrestricted land use (e.g., no land use controls), the words "OU Closure" will be used instead of "RA Completion" in the title of this section. The following items are included as applicable:

(1) "As detailed in Section 4.0, the operations (or MNA, as applicable) activities required for the RA have met the acceptance criteria established in the approved CMIP/RAIP and/or PCR, but with allowances for deviations outlined in Section 3.0."

(2) "As detailed in Section 5.1, the RA is verified as complete, and operations have attained the ROD RAOs. Section 5.1's verification is typically based upon the result of performance tests and quality control inspections provided in the verification of Section 4.0."

(3) "As outlined in Section 5.2, the final walkdown inspection with participation of USEPA and SCDHEC (as applicable) has been performed and issues have been addressed and closed out."

5.1 Verification of Remedial Action Completion

This section provides the verification that RAOs established in the ROD have been met through field implementation of the RAs per the approved CMIP/RAIP and that no further RCRA/CERCLA response is needed to protect human health and the environment.

The primary RA components (e.g., a cover, soil treatment, groundwater treatment, etc.) are listed including a certification statement on how each applicable RAO was met. The basis for the verification of RA completion in accordance with the ROD requirements is provided.

Documentation of the results of any analytical sampling and testing is described along with the records storage of the data is provided. Applicable post-closure activities (e.g., LUCs, five-year remedy reviews, etc.) are referenced as being described in Section 7.0 of this CMIR/RACR. The degree of cleanup or protection as specified in the ROD(s) for all RAs and for all pathways of exposure described in the CSM is provided.

5.2 Final Inspection for Acceptance of Closure

The purpose of this section is to document the final joint walkdown performed by the Project

Team, U.S. Department of Energy (and SRS project team), SCDHEC and USEPA. A summary and participants is provided in an Appendix to the CMIR/RACR. A summary of previous inspections presented in earlier PCRs is provided.

6.0 AS-BUILT DOCUMENTATION

6.1 As-Built Drawings

This section indicates that as-built drawings, which are updated PCR construction drawings and as-built operations drawings for the completed project, are included in an appendix of this CMIR/RACR. Drawings that reflect the RA completion configuration are also included in an appendix. Post-CMIR/RACR RA components (e.g., cover, fencing, etc. needed per the Land Use Control Implementation Plan [LUCIP]) are included in the as-built drawings.

6.2 Well Modifications

This section provides a summary or identifies an appendix where reports of any well modifications (e.g., well abandonment, well extension or protection) are located.

7.0 POST-CMIR/RACR ACTIVITIES

For Post-CMIR/RACR activities, the OU-specific LUCIP (if applicable) is referenced. Maintenance and LUCs per the LUCIP will be reported during the five-year review of the remedy.

7.1 Five-Year Remedy Review

Section 300.430(f)(ii) of the National Oil and Hazardous Substances Contingency Plan (NCP) requires that a five-year remedy review be performed if hazardous substances, pollutants, or contaminants above levels that allow for unlimited use and unrestricted exposure remain in the OU. This section identifies that a five-year review of the remedy will be performed (if required) for as long as needed to ensure that the remedy continues to provide adequate protection of human health and the environment.

8.0 PROJECT COSTS

A table comparing the final costs of the RA activities completed in the construction phase to the

original ROD cost estimate is provided in this section. Cost deviations, beyond –30% or +50%, from the ROD cost estimate are discussed. The cost breakdown is limited to that which was presented in the ROD.

9.0 REFERENCES

This section provides a list of the documents referred to in the CMIR/RACR and may include the following reference documents.[1]

Close Out Procedures for National Priorities List Sites, USEPA OLEM Directive 9320.2-23, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., June 2022.

Guidance for Management of Superfund Remedies in Post Construction, USEPA OLEM Directive 9200.3-105, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., February 2017.

Figures and Tables

A sample of the figures and tables that may be included in the CMIR/RACR are listed below. Figures and tables will be specific for the OU/facility. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location on SRS Map
Figure 2. Pre-Remedial Action Site Plan
Figure 3. Nature and Horizontal and Vertical Extent of COCs
Figure 4. Conceptual Site Model
Figure 5. Photos of RA Implementation (if appropriate)

Table 1. Chronology of Events
Table 2. Summary of Design Changes
Table 3. As-Built CMIP/RAIP Characteristic Test Results
Table 4. Project Cost Comparison

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

List of Appendices

Appendices and attachments are included as appropriate.

Examples of appendices are well modification records, well abandonment reports, test results, RA start notification letters, USEPA/SCDHEC walkdown memos, list of participants of USEPA/SCDHEC inspections, etc.

Attachments are information that was previously presented in stand-alone documents with its own document numbers. Examples of attachments are as-built drawings and reports referenced in the body of the CMIR/RACR.

POST-CONSTRUCTION REPORT/CORRECTIVE MEASURES IMPLEMENTATION REPORT/REMEDIAL ACTION COMPLETION REPORT FORMAT

A Post-Construction Report/Corrective Measures Implementation Report/Remedial Action Completion Report (PCR/CMIR/RACR) is prepared for Resource Conservation Recovery Act (RCRA) and/or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) operable units (OUs) when all portions of the remedial action (RA) for an OU are completed, no monitored natural attenuation (MNA) or long-term operation of constructed equipment or systems for treatment of contaminants in the source unit or in the groundwater are required, and all remedial action objectives (RAOs) for the OU have been attained. A CMIR/RACR is prepared at the completion of the RA for OUs where a PCR was previously generated for a portion of the RA. The CMIR is not included in the document if the OU is CERCLA only.

1.0 GENERAL DESCRIPTION

1.1 Purpose and Scope

The purpose of the PCR/CMIR/RACR is to document the completion of construction activities and field implementation of the RA and provide verification that all of the RAOs established in the ROD have been met for the closure of the OU. Activities performed to implement the RA requirements are summarized. Reference to the Record of Decision (ROD) and the Corrective Measures Implementation Plan /Remedial Action Implementation Plan (CMIP/RAIP) as containing the requirements of the RA is included.

The final inspection of construction by U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) is referenced. A statement is included that the PCR/CMIR/RACR documents that the RAOs have been met, and no further RCRA/CERCLA response is needed to protect human health and the environment.

Items that will be addressed in the PCR/CMIR/RACR include the following:

- A brief description of the OU background, including a brief statement on RA requirements and objectives from the ROD
- A chronology of completed events related to remediation of the OU
- A summary of construction activities performed
- Deviations from the original design of the approved CMIP/RAIP
- Performance standards and quality control inspections, including a summary of performance test results documenting verification of compliance with the acceptance criteria in the CMIP/RAIP
- Final inspection and verification of OU closure
- As-built drawings
- Land use controls (LUCs), if required
- Project costs

Clarification is made that the PCR and CMIR/RACR are combined because the RA for the OU is complete and does not require long-term RAs, i.e., the final RA does not require MNA or long-term operation of constructed equipment or systems for treatment of contaminants in the source unit or in the groundwater.

1.2 Operable Unit Background

This section identifies if the source OU is listed as a RCRA 3004(u) Solid Waste Management Unit and/or CERCLA Unit in Appendix C of the FFA for Savannah River Site (SRS).

Since earlier documents have provided the same information in detail, the PCR/CMIR/RACR provides a brief description of the OU with emphasis on RA requirements, including whether the OU is a RCRA and/or CERCLA unit.

Previous community involvement activities are summarized. A condensed presentation of information is provided since the same information has been covered in greater detail in previous

documents required by the FFA process; however, this document is supposed to be a stand-alone document presenting all aspects of the RA.

1.2.1 General Description and Location

This section provides a general description of the OU. Since earlier documents have provided the same information in detail, the PCR/CMIR/RACR provides a brief description of the OU with emphasis on RA requirements. If the OU is represented by subunits for evaluation purposes, the subunits and associated media addressed by the RA are introduced. A location figure is included.

1.2.2 Nature and Extent of Contamination

This section briefly describes the constituents of concern (COCs) within the respective media of concern (i.e., soil, sediment, groundwater, etc.) as identified in the ROD for the RA. The associated risks, specific components of the OU requiring remediation, and locations of COCs with respect to the zone of remediation (areas and depths), is provided. Because the information is covered in greater detail in previous FFA documents, a condensed presentation (synopsis or summary) is provided in this section. Figures or maps to illustrate the nature and horizontal and vertical extent of COCs within the respective media of concern and area(s) targeted for the RA are referenced.

1.3 Remedial Action Requirements and Objectives

1.3.1 Remedial Action Objectives

This section lists the remedial action objectives (RAOs) for the OU just as stated in the ROD. The RAOs are listed in bullet form and by subunit if appropriate. The future land use (i.e., industrial, unrestricted, etc.) is identified with a description of how the RAOs support the future land use.

1.3.2 Selected Remedial Action

The specific elements of the selected RA as described in the ROD are provided in this section. The discussion will include a brief explanation of how the implementation of this RA achieves RAOs and mitigates site risks (e.g., prevent contamination from reaching the groundwater by treating the contaminated soils, etc.). A conceptual site model (CSM) to illustrate how implementation of the RA breaks the exposure pathways is provided.

1.4 Chronology of Events

This section provides a list of major milestones and dates related to the RA for the OU, including the ROD signatures, CMIP/RAIP approval, major construction events (e.g., RA start, mobilization, pilot test, etc.), verification sampling and performance testing, inspections, identification and resolution of non-conformances (if any), demobilization and final inspection (regulatory walkdown) of completed construction.

2.0 CONSTRUCTION ACTIVITIES

The purpose of this section is to provide a summary of construction activities performed during the construction phase in accordance with the approved CMIP/RAIP. The names and roles of prime subcontractors associated with the RA in addition to a brief narrative following the sequence of activities listed in Section 1.4 are included. Any treatment process required to implement the remedial design, materials and equipment used, successes and problems encountered during construction and resolution of problems (including innovative solutions, if any), and causes for delay are discussed. Unexpected conditions encountered in the field, particularly those that affected the scope or schedule of the construction work, are described in this section.

The specific details of the unit's waste management plan including a description of the waste types, waste volumes, characterization methods, (e.g., testing methods), disposal and transportation during construction, as applicable to the selected RA, are provided.

3.0 DEVIATIONS FROM ORIGINAL DESIGN

This section identifies design changes from the approved CMIP/RAIP required during construction as well as the technical basis for those changes. A discussion of all changes made during construction, regardless of whether those changes were previously communicated to SCDHEC and USEPA is provided. The process and scope of design change notifications are discussed in the CMIP/RAIP.

A table providing a summary of all design changes, along with the basis and resolution of deviations from the original design, may be provided. Where applicable, a statement on whether the deviation still meets a performance criterion is included.

4.0 VERIFICATION SAMPLING, TESTING, ANALYSIS, PERFORMANCE STANDARDS, AND CONSTRUCTION QUALITY CONTROL

4.1 Performance Requirements/Standards

The purpose of this section is to cite appropriate references to the performance requirements (acceptance criteria) as required per the CMIP/RAIP for each RA component (e.g., cover, soil treatment, soil disposal, etc.). If applicable, a brief discussion of collection of test samples, a comparison of test results with CMIP/RAIP acceptance criteria, and a description of how those criteria were met is included. Any non-conforming conditions identified during the quality control inspection and how those non-conformances were resolved to meet the specified performance criteria are discussed.

A list or table of performance requirements, acceptance criteria and/or process control parameters as identified in the approved CMIP/RAIP is provided. A summary table which lists the specific attributes required and the specific tests for each attribute may be provided.

4.2 Construction and Quality Control

This section provides a summary of quality assurance and quality control procedures that were implemented to ensure successful implementation of the RA.

5.0 VERIFICATION OF REMEDIAL ACTION COMPLETION AND FINAL INSPECTION

The purpose of this section is to provide a statement of completion for the RA. Specific language to be included is recommended as follows:

If the OU is being released for unrestricted land use (e.g., no LUCs) the words “OU Closure” will be used instead of “RA Completion” in the title of this section. The following items are included as applicable:

(1) "As detailed in Section 4.0, the construction activities required for the RA have met the acceptance criteria established in the approved CMPI/RAIP, but with allowances for deviations outlined in Section 3.0."

(2) "As detailed in Section 5.1, the RA is verified as complete, and construction and testing was in accordance with the CMIP/RAIP. Section 5.1's verification is typically based upon the result of performance tests and quality control inspections provided in the verification in Section 4.0."

(3) "As outlined in Section 5.2, the final walkdown inspection with participation of USEPA and SCDHEC (as applicable) has been performed and issues have been addressed and closed out."

5.1 Verification of Remedial Action Completion

This section provides the verification that RAOs established in the ROD have been met through field implementation of the RAs per the CMIP/RAIP and that no further RCRA/CERCLA response is needed to protect human health and the environment.

The primary RA components (e.g., a cover, soil treatment, groundwater treatment, etc.) are listed including a certification statement on which and how each applicable RAO was met. The degree of cleanup or protection as specified in the ROD(s) for all RAs and for all pathways of exposure described in the CSM is provided.

Documentation of the results of any analytical sampling and testing is described along with the records storage of the data is provided. Applicable post-closure activities (e.g., LUCs, five-year remedy reviews, etc.) are referenced as being described in Section 7.0 of this PCR/CMIR/RACR.

5.2 Final Inspection for Acceptance of Closure

The purpose of this section is to document the final joint walkdown performed by the U.S. Department of Energy (and SRS project team), SCDHEC, USEPA, and the SRS project team. A summary and participants of the inspection is provided in an appendix of the PCR/CMIR/RACR.

6.0 AS-BUILT DOCUMENTATION

6.1 As-Built Drawings

This section indicates if as-built drawings are available for the project and, if so, a reference to the drawings in an appendix of the PCR/CMIR/RACR is included.

6.2 Well Modifications

This section provides a summary or identifies an appendix where reports of any well modifications (e.g., well abandonment, well extension or protection) are located.

7.0 POST-PCR/CMIR/RACR ACTIVITIES

For Post-PCR/CMIR/RACR activities, the OU-specific Land Use Control Implementation Plan (LUCIP) is referenced. Maintenance and LUCs per the LUCIP (if applicable) will be reported during the five-year review of the remedy.

7.1 Five-Year Remedy Review

Section 300.430(f)(ii) of the National Oil and Hazardous Substances Contingency Plan (NCP) requires that a five-year remedy review be performed if hazardous substances, pollutants, or contaminants above levels that allow for unlimited use and unrestricted exposure remain in the OU. This section identifies that a five-year review of the remedy will be performed to ensure that the remedy continues to provide adequate protection of human health and the environment.

8.0 PROJECT COSTS

A table comparing the final costs of the RA activities completed in the construction phase to the original ROD cost estimate is provided in this section. Cost deviations, beyond –30% or +50%, from the ROD cost estimate are discussed. The cost breakdown is limited to that which was presented in the ROD.

9.0 REFERENCES

This section provides a list of the documents that are referred to in the PCR/CMIR/RACR and may include the following reference documents.[1]

Guidance for Management of Superfund Remedies in Post Construction, USEPA OLEM Directive 9200.3-105, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., February 2017.

Close Out Procedures for National Priorities List Sites, USEPA OLEM Directive 9320.2-23, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, Washington, D.C., June 2022.

Figures and Tables

A sample of the figures and tables that may be included in the PCR/CMIR/RACR are listed below. Figures and tables will be specific for the OU. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location on SRS Map
Figure 2. Pre-Remedial Action Site Plan
Figure 3. Nature and Horizontal and Vertical Extent of COCs
Figure 4. Post-Remediation Action Site Plan
Figure 5. Conceptual Site Model
Figure 6. Photos of RA Implementation (if appropriate)

Table 1. Chronology of Events
Table 2. Summary of Design Changes
Table 3. As-Built CMIP/RAIP Characteristic Test Results
Table 4. Project Cost Comparison

List of Appendices

Appendices and attachments are included as appropriate.

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

Examples of appendices are well modification records, well abandonment reports, test results, RA start notification letters, USEPA/SCDHEC walkdown memos, list of participants of USEPA/SCDHEC inspections, etc.

Attachments are information that was previously presented in stand-alone documents with its own document numbers. Examples of attachments are as-built drawings and reports referenced in the body of the PCR.

This page is intentionally left blank.

SAMPLING AND ANALYSIS PLAN FORMAT

1.0 INTRODUCTION

This section provides an introduction to the Sampling and Analysis Plan (SAP) prepared in accordance with the U. S. Environmental Protection Agency (USEPA) *Uniform Federal Policy for Quality Assurance Project Plans* and the *Area Completion Projects Programmatic Quality Assurance Project Plan for Environmental Data Collection and Management*. Project or task specific information for the operable unit (OU)/facility is documented in the SAP and refers to the Savannah River Site (SRS) program level Quality Assurance Project Plan (QAPP) for the program level quality objectives, standard operating procedures, and quality assurance/quality control procedures.

1.1 Operable Unit/Facility Name and Purpose for Sampling

This section introduces the OU/facility and presents the reason/purpose for sampling, relevant background information, the regulatory framework for the OU/facility investigation, and any evaluations and decisions made during the scoping process.

1.2 Operable Unit/Facility Location

This section provides a brief description of where the OU/facility is located at SRS and its proximity to nearby OUs/facilities, if any. A figure is provided to illustrate the sampling area location.

1.3 Statement of Broad Sampling Objectives

This section presents the project-specific objectives for conducting the sampling event. This is a general description of the media to be sampled and specific uses for the data. The level of detail in individual SAP documents will vary according to the work being performed and the intended use of the data. For this reason, a graded approach should be used for establishing the project requirements according to the intended use of the results, the type(s) and quality of data needed, the degree of confidence needed in the decisions supported by the data. The degree of

documentation, level of effort, and detail will vary based on the scope, complexity, and cost of the project.

2.0 SAMPLING UNIT BACKGROUND

2.1 Operable Unit/Facility Physical and Geographical Description

This section presents background information about the physical characteristics of the OU/facility such as unit-specific geologic and hydrogeologic description (if available), climatic conditions, physical setting, waste composition, history, and size and/or volume.

2.2 Operational History

This section presents any operational knowledge about the OU/facility such as history of contamination, type of contaminants, nature of contamination, and any details concerning process knowledge.

2.3 Previous Investigations/Regulatory Actions

This section provides a brief discussion of the regulatory history, previous sampling results, chronology, and outcome of previous investigations and any remedial, removal, or interim actions previously completed for the OU/facility. A reference to relevant previous document(s) is provided.

2.4 Summary of Existing Data Compared to Risk-Based Thresholds

This section provides a summary of the detected OU/facility contaminant concentrations by media compared to risk-based thresholds, Maximum Contaminant Levels (MCLs), and/or applicable or relevant and appropriate requirements. Risk-based thresholds include USEPA Regional Screening Levels (RSLs) and Preliminary Remediation Goals (PRGs) for soil, sediment, and tap water. MCLs are risk-based drinking water concentrations that have been determined based upon consideration of the limits of detection, available treatment technologies, and cost and are compared to groundwater concentrations. Concrete media is also compared to risk-based RSLs/PRGs as appropriate.

3.0 DATA QUALITY OBJECTIVES

This section introduces the Data Quality Objective (DQO) process. The DQO process is a series of logical planning steps that guides managers or staff to a plan for the resource-effective acquisition of environmental data. The DQO process is used to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient type, quality and quantity to support the goals of the study. The DQO steps may be presented for the OU/facility, by subunits, or by media. A reference to the DQO table(s) is made.

3.1 State the Problem

This section presents a concise and detailed statement(s) of the problem(s) which will be resolved with the data being collected. This section will describe the problem, develop a conceptual site model (CSM) of the environmental hazard(s) to be investigated, identify the general type of data needed, discuss alternative approaches to the investigation and solving the problem, and identify any constraints associated with data collection and data assessment.

3.2 Identify the Decisions of the Study

This section presents the study questions, alternative outcomes, and decision statements of the study. This section identifies principal study questions and defines alternative actions based on possible outcomes which result from answering the study questions, using the study question(s) and alternative actions to make a decision statement, and organizing multiple decisions into an order of priority.

3.3 Identify the Inputs to the Decisions

This section identifies the sources of information that will be used to answer decision statements and form the basis for what will be used to guide the choices to be made later. This section identifies the types of and potential sources of information, information basis for specifying performance or acceptance criteria, and the availability of appropriate sampling and analysis methods. USEPA RSL/PRG/MCL (as appropriate) screening tables are used as the basis to guide decisions.

3.4 Define the Boundaries of the Study

This section defines the spatial and/or temporal boundaries of the OU/facility. This section defines the target population, determines any spatial or temporal boundaries, identifies practical constraints, and defines the scale of inference (decision unit). The decision unit and the scale on which decisions are made are defined in this section.

3.5 Develop Decision Rules and Analytical Approach

This section specifies the population parameters for making decisions and develops "If-Then-Else" decision rules for the project. This section specifies the parameters considered to be important to make inferences about the target population, chooses an RSL/PRG/MCL (from Section 3.3) that sets the boundary between one outcome of the decision process and an alternative, and verifies if sampling and analysis methods exist that have detection limits below the risk-based threshold.

3.6 Specify the Limits on Decision Errors

The USEPA has developed the DQO process as the agency's recommended planning process when environmental data are used to select between two or more alternatives or to derive an estimate of contamination. This section presents the rationale for a biased sampling design if appropriate for the OU/facility. If a statistical-based sample design is required such as for confirmation sampling, then this section will specify the decision rule(s) as a statistical hypothesis test and determine the acceptable limits on decision errors. A discussion of the performance or acceptance criteria that the data will need to achieve in order to minimize the possibility of either making erroneous conclusions or failing to maintain uncertainty estimates within acceptable levels will be included in this section. The Project Quality Objectives (PQOs) are included in this section in order for the developers of the Data Usability Report to assess whether the sampling design has achieved its quality objectives for the collected data to be qualified for project decision-making.

3.7 Optimize Design for Obtaining Data

This section documents the selected sampling design that will yield data that will best attain the quality objectives for the project. This section will summarize all the information from the previous steps, apply this information to identify alternative sampling designs that are appropriate

for use, and document a sampling design that will yield the data that best answers the study questions while ensuring sufficient data quality.

4.0 SAMPLING DESIGN AND RATIONALE

Implementation of the SAP to obtain decision-quality data for the OU/media or facility/media is described in the remaining sections of the SAP. The following section describes how the plan is to be implemented to collect the physical data to meet the criteria developed during the DQO process.

4.1 Rationale for Operable Unit/Media [or Facility/Media]

This section presents a description outlining the rationale for the sampling design/strategy using the CSM. This section is also a comprehensive description of sample collection and how it integrates with the sample design/strategy. These are detailed statements of how the number and types of samples, the laboratory analyses (e.g. Target Analyte List/Target Compound List [TAL/TCL]), sample locations, analytical data quality, and sampling design achieve the performance and acceptance criteria.

The rationale and details of the sampling design/strategy are summarized in the DQO Worksheets for the OU, each subunit, and/or sampling media. DQO worksheets are provided for each media type (i.e., soil, sediment, surface water, groundwater, and concrete).

5.0 ANALYTICAL PLAN

This section describes the data quality levels for each type of data being collected. All data collection under the SAP will follow the SRS program level QAPP. The data quality level needed is determined by the intended use of the data.

5.1 Data Quality Levels for Operable Unit/Media

This section presents the data quality level for the OU/media [or facility/media]. Tables may be used to illustrate analytical data quality levels and and their correlated quality assurance/quality

control field samples. The difference between screening data and definitive data in accordance with the USEPA Uniform Federal Policy is discussed in this section.

5.2 Field Analytical Sampling Quality Assurance/Quality Control

This section references a table with the type and number of regular (soils, sediments, surface water, and groundwater) and field quality control (QC) samples (field duplicates, rinsate/equipment blanks, trip blanks, and split samples) required for collection in the sampling plan. The number and type of field samples can be variable depending upon the needs of the project. If there are no field quality assurance (QA)/QC samples collected, the data is of unknown quality and will not be validated or used for remedial decision making.

5.3 Sample Matrix Table

This section references a Sampling Matrix Table to include all the below information.

A) Sample Count
B) Coordinates (may change due to field conditions)
C) Sample Identification
D) Sample Number
E) Field QA/QC Samples
F) Sample Collection Method
G) Media
H) Sample Depth (depth below ground surface)
I) Subunit Location
J) Analytical Suites

The sample matrix table or text will provide a summary of the number of each type of sample collected.

5.4 Sample Location Map

This section will reference a figure that illustrates the proposed locations of samples to be collected for all matrices. Contingency sample locations are also included.

6.0 FIELD IMPLEMENTATION

6.1 List of Sampling/Collection Equipment

This section lists the type(s) of sampling/collection equipment needed to execute the Field Implementation Plan. Examples include hand augers, hand scoops, organic vapor analyzer meter, portable/hand-held pH meter, portable/hand-held conductivity meter, lanthanum-bromide gamma detector, global positioning system unit, KIJ-5 radio, sample bottles with preservatives, and coolers.

6.2 Investigation Derived Waste

This section provides that Investigation Derived Waste (IDW) will be managed according to the OU-specific IDW management plan developed for the project.

7.0 REFERENCES

This section provides a list of the documents that are referred to in the SAP, and may include the following guidance documents.[1]

Uniform Federal Policy for Quality Assurance Project Plans, EPA-505-B-04-900A, DOD-DTIC-ADA-427785, Intergovernmental Data Quality Task Force (U.S. Environmental Protection Agency, U.S. Department of Defense, U.S. Department of Energy), Version 1 Final, March 2005.

Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C., February 2006.

Area Completion Projects Programmatic Quality Assurance Project Plan for Environmental Data Collection and Management, ERD-AG-2005-00001, Revision 5, Savannah River Site, Aiken, SC, April 2012.

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

Figures and Tables

A sample of the figures and tables that may be included in the SAP are listed below. Figures and tables may also be presented in appendices if appropriate. Figures and tables will be specific for the OU/facility.

Figure 1. Location of the Sampling Unit
Figure 2. CSM for Contaminated Media
Figure 3. Map Illustrating Sampling Location for All Media

Table 1. Soil Analyte Concentrations Compared to RSLs/PRGs
Table 2. Water Analyte Concentrations Compared to RSLs/PRGs and/or MCLs
Table 3. Data Quality Objectives Worksheet for Soil Media
Table 4. Data Quality Objectives Worksheet for Groundwater Media
Table 5. Data Quality Objectives Worksheet for Surface Water and Sediment Media
Table 6. Minimum Field Quality Control/Quality Assurance Sampling Requirements
Table 7. Laboratory Analytical Specifications Table TAL/TCL Analytes for Soil and Sediment Media
Table 8. Laboratory Analytical Specifications Table for TAL/TCL Analytes for Surface Water or Groundwater Media
Table 9. Laboratory Analytical Specifications Table for Radiological Analytes in Soil, Sediment, Surface Water, and Groundwater Media
Table 10. Preservatives, Holding Times, and Sample Containers
Table 11. Sampling Matrix Table

DATA USABILITY REPORT FORMAT

1.0 PROJECT SUMMARY

The purpose of the Data Usability Report is to present analytical data verification, validation, and usability assessment results for sampling at an operable unit/facility. This section presents the number of regular field samples, number of field duplicates (FD), number of sample locations, and number of trip blanks (TB) for a project. The samples, along with the requested analytical analyses, are listed in tabular format as shown in the example below.

Table 1. Sample Identification (ID) Summary

Station ID	Sample ID	Sample Type	Sample Date	Sample Time	Matrix	Interval	Analysis Requested
A-ASHPILE-01	*A-ASHPILE0049*	*REG*	*26-Aug-21*	*2:30 PM*	*ASH*	*0 - 1 ft*	*1, 2, 3, 4, 8, 9, 10, 11*
A013-01	*A013-00000008*	*REG*	*14-Jan-22*	*10:00 AM*	*SOIL*	*0 - 1 ft*	*1, 8, 9*, 11*
A013-01	*A013-00000009*	*REG*	*14-Jan-22*	*10:10 AM*	*SOIL*	*1 - 4 ft*	*1, 8, 9*, 11*
A013-02	*A013-00000006*	*REG*	*20-Jan-22*	*9:25 AM*	*SOIL*	*0 - 1 ft*	*1, 8, 9*, 11*
A013-02	*A013-00000007*	*REG*	*20-Jan-22*	*9:50 AM*	*SOIL*	*1 - 4 ft*	*1, 8, 9*, 11*
A013-03	*A013-00000004*	*REG*	*20-Jan-22*	*11:40 AM*	*SOIL*	*0 - 1 ft*	*1, 8, 9*, 11*
TRIP BLANK	*AOUTFALL00001*	*TB*	*14-Jan-22*	*10:00 AM*	*WATER*		*12*

Analyses Requested

1. Target Analyte List (TAL)/Target Compound List (TCL)
2. Alkalinity
3. Sulfate
4. pH
5. Total Suspended Solids (TSS), Total Dissolved Solids (TDS)
6. Total Phosphates
7. Tritium
8. Gross Alpha/Non-Volatile Beta (GA/NVB)
9. Alpha Spectroscopy (e.g., Uranium, Thorium)
10. Radium-226, Radium-228
11. Gamma Pulse Height Analysis (PHA)
12. Volatile Organic Analysis (VOA)

*Radiological speciation only performed on soil/sediment samples when Gross Alpha >/=20 pCi/g or Non-Volatile Beta >/=50 pCi/g.

The total number of analytical records produced, number of regular sample records, and number of field quality control (QC) records are listed in tabular format as shown in the example below.

Table 2. Total Number of Records

Number of Records	Chemical	Radiochemical	Totals
Analytical	*13625*	*3603*	*17228*
Field QC	*2182*	*415*	*2597*
Totals	*15807*	*4018*	*19825*

The verification process is conducted to review completeness of the sampling and analytical requirements. Validation is performed to assess compliance with methods, procedures, and contracts and to assess a comparison of the data to measurement performance criteria. A usability

assessment provides the data user with an assessment of whether the process execution and resulting data meet project quality objectives in the Sampling and Analysis Plan and Quality Assurance Project Plan.

The data is validated to determine if the records conform to the technical criteria associated with definitive data per standard operating procedures. A brief validation summary for the project is provided in tabular format as shown in the example below.

Table 3. Environmental Record Review Qualifier Summary

	Detects		Non-detects		Rejected	
Method Code	**# NULL Qualifiers**	**# J Qualifiers**	**# U Qualifiers**	**# UJ Qualifiers**	**# R Qualifiers**	**Total**
A-01-RMOD	*209*	*29*	*63*	*0*	*0*	*301*
EPA300.0	*25*	*18*	*0*	*0*	*0*	*43*
EPA365.4	*30*	*5*	*0*	*0*	*0*	*35*
EPA6010C	*561*	*147*	*169*	*79*	*13*	*969*
EPA6020A	*690*	*163*	*93*	*0*	*0*	*946*
Total	*2468*	*737*	*15417*	*219*	*237*	*19078*
% of Total	*13%*	*4%*	*81%*	*1%*	*1%*	*100%*

2.0 ASSESSMENT OF PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, COMPLETENESS, AND SENSITIVITY DATA QUALITY INDICATORS AND MEASUREMENT PERFORMANCE CRITERIA

This section discusses the analytical data in terms of the following indicators of data quality: precision, accuracy, representativeness, comparability, and completeness. Precision is determined from the FD and laboratory duplicate (LD) analyses and indicates the consistency of field and laboratory techniques. Accuracy is determined from the laboratory control samples, matrix spikes (MS), and the results of the method, field, trip, and rinsate blanks and indicates the ability of the laboratory to generate correct results. Representativeness measures the degree to which data accurately represents a population characteristic or process or environmental condition. Comparability expresses the confidence with which data from different laboratories are considered to be equivalent. Completeness measures the amount of data resulting from the data collection activity.

2.1 Precision

This section discusses the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. FD data measure the repeatability of the sampling and analytical techniques, and LDs measure the ability of the laboratory to reproduce a result. The number of records rejected due to precision issues is presented. Precision is expressed in terms of the relative percent differences.

2.2 Accuracy

This section discusses the accuracy of the data as defined by closeness of agreement between an observed value and an accepted reference value. The sample types used to evaluate accuracy are performance evaluation studies, laboratory control samples (LCS), surrogate spikes, MS, matrix spike duplicates (MSD), method blanks (MB), TB, and rinsate blanks (RB). The number of records (by constituent) rejected because the MS was outside limits is presented.

2.3 Representativeness

This section discusses the representativeness of the data measured as the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. The representativeness of samples collected is controlled by adhering to the detailed descriptions of sampling procedures (e.g., sample hold times, sample preservation, sample temperature).

2.4 Comparability

This section discusses the comparability of the data measured as the degree to which different methods, data sets, and decisions agree or can be represented as similar. The comparability of the data from the laboratories is based on the results of the split samples and on confirmation that the laboratories used the same standardized procedures for sample analysis, the same reporting unit, and obtained similar quantitation limits. For at least 5% of the sample locations, a split sample is collected and sent to the designated QC laboratory.

2.5 Completeness

This section discusses the completeness of the data measured as the amount of valid data (excluding missing or rejected samples/results) obtained from a measurement process that achieves the project goals as compared to the amount of data planned to be obtained by the project. The Quality Assurance completeness objective for Resource Conservation and Recovery Act Feasibility Investigation/Remedial Investigation projects is to obtain valid field and laboratory analytical results for at least 90% of the samples collected during the project. Accountability of samples collected, from field to final disposal, must be 100%. When review of the data and documentation determines the data to be incomplete, the impact relative to the project objective will be assessed and documented.

2.6 Sensitivity

Sensitivity is the ability of the method or instrument to detect the target analytes at the level of interest (e.g., Regional Screening Levels [RSL] or Primary Drinking Water Maximum Contaminant Levels [MCL]). The sample quantitation limit (SQL) is the minimum concentration of an analyte that can be routinely identified and quantified above the method detection limit (MDL) by a laboratory. Sensitivity can be determined by comparing the MDLs and SQLs for each analyte and for each matrix (e.g., soil or groundwater). The project team should document the project-required MDLs and SQLs for each matrix and analyte, which will be compared against the criteria of interest to ensure data usability.

3.0 VALIDATION FINDINGS

3.1 Holding Times

This section discusses the holding times for the reported analyses and identifies whether the analyses were within the recommended limits and if qualification was required. The holding times are presented in tabular format as shown in the example below.

Table 4. Holding Time Review Qualifier Summary

Method Code	Total # of Records	# of Records Qualified for Hold Times	Associated Samples Qualified
EPA300.0	*43*	*15*	*A-ASHPILE0021, A-ASHPILE0022, A-ASHPILE0023, A-ASHPILE0033, A-ASHPILE0034, A-ASHPILE0035, A-ASHPILE0036, A-ASHPILE0037, A-ASHPILE0038, A-ASHPILE0039, A-ASHPILE0040, A-ASHPILE0041, A-ASHPILE0042, A-ASHPILE0043, A-ASHPILE0044*

3.2 Preservation

This section discusses whether the chemical and physical preservation for the reported analyses were properly applied and if qualification was required. The preservation review is presented in tabular format as shown in the example below.

Table 5. Preservation Review Qualifier Summary

Method Code	Total # of Records	# of Records Qualified for Preservation	Associated Samples Qualified
A-01-RMOD	*301*	*0*	
EPA300.0	*43*	*0*	
EPA365.4	*35*	*0*	
EPA6010C	*969*	*0*	
EPA6020A	*946*	*0*	
EPA7470A	*3*	*0*	
EPA7471B	*84*	*0*	
EPA8081B	*1723*	*0*	
EPA8081BSCNPDES	*60*	*0*	
EPA8082A	*609*	*0*	

3.3 Calibration, Identification, and Quantitation

This section discusses whether all calibration, identification, and quantitation criteria for the reported analyses were within the recommended limits and if qualification was required. The calibration review is presented in tabular format as shown in the example below.

Table 6. Calibration, Identification, and Quantitation Review Summary

Method Code	Total # of Records	# of Records Qualified for Calibration, Identification and Quantitation	Associated Samples Qualified
EPA6010C	*969*	*142*	*ACPRB00000001, ACPRB00000002, ACPRB00000003, ACPRB00000004, ACPRB00000005, ACPRB00000006, ACPRB00000007, ACPRB00000008, ACPRB00000009, ACPRB00000010, ACPRB00000011, ACPRB00000012, ACPRB00000013, ACPRB00000014, ACPRB00000015, ACPRB00000016, ACPRB00000017, ACPRB00000018, ACPRB00000019, ACPRB00000020, ACPRB00000021, ACPRB00000022, ACPRB00000029, ACPRB00000030,*

3.4 Trip Blanks

This section discusses whether the TB results for the reported analyses were within the recommended limits and if qualification was required. The review of the TB data is presented in tabular format as shown in the example below.

Table 7. Trip Blank Review Qualifier Summary

Method Code	Total # of TB Records	# of TB Records Qualified	Associated Samples Qualified
EPA8260B	*618*	*5*	*A013-00000009*

3.5 Method Blanks

This section discusses whether the MB results for the reported analyses were within the recommended limits and if qualification was required. The review of the MB results is presented in tabular format as shown in the example below.

Table 8. Method Blank (MB) Review Qualifier Summary

Method Code	Total # of MB Records	# of MB Records Qualified	Associated Samples Qualified
A-01-RMOD	36	22	A-ASHPILE0017, A-ASHPILE0028, A-ASHPILE0029, A-ASHPILE0032, A-ASHPILE0039, A-ASHPILE0040

3.6 Laboratory Duplicate Relative Percent Difference

This section discusses whether the LD results for the reported analyses were within the recommended limits and if qualification was required. The review of the LD results is presented in tabular format as shown in the example below.

Table 9. Laboratory Duplicate Qualifier Summary

Method Code	Total # of LD Records	# of LD Records Qualified	Associated Samples Qualified
A-01-RMOD	*33*	*3*	*A-ASHPILE0018, A-ASHPILE0021, A-ASHPILE0022*

3.7 Field Duplicate Relative Percent Difference

This section discusses whether the FD results for the reported analyses were within the recommended limits and if qualification was required. The review of the FD data is presented in tabular format as shown in the example below**.**

Table 10. Field Duplicate Qualifier Summary

Method Code	Total # of FD Records	# of FD Records Qualified	Associated Samples Qualified
EPA300.0	*4*	*1*	*A-ASHPILE0027, A-ASHPILE0054*

3.8 Matrix Spike Recovery

This section discusses whether the MS and MSD recoveries for the reported analyses were within the recommended limits and if qualification was required. The review of the MS and MSD recoveries is presented in tabular format as shown in the example below**.**

Table 11. MS and MSD Recovery Qualifier Summary

Method Code	Total # of MS/MSD Records	# of MS/MSD Records Qualified	Associated Samples Qualified
EPA365.4	*12*	*4*	*ACPRB00000033, ACPRB00000037*

3.9 Laboratory Control Samples Recovery

This section discusses whether the LCS recovery for the reported analyses were within the recommended limits and if qualification was required. The review of the LCS recovery is presented in tabular format as shown in the example below**.**

Table 12. LCS Qualifier Summary

Method Code	Total # of LCS Records	# of LCS Records Qualified	Associated Samples Qualified
EPA903.0MOD	*5*	*1*	*A-ASHPILE0037, A-ASHPILE0041*

3.10 Surrogate/Tracer Recovery

This section discusses whether the surrogate/tracer recovery for the reported analyses were within the recommended limits and if qualification was required. The review of the surrogate/tracer recovery is presented in tabular format as shown in the example below**.**

Table 13. Surrogate/Tracer Recovery Qualifier Summary

Method Code	Total # of Surrogate/ Tracer Records	# of Surrogate/Tracer Records Qualified	Associated Samples Qualified
EPA903.0MOD	*43*	*3*	*A-ASHPILE0011, A-ASHPILE0033, A-ASHPILE0041*

3.11 Split Samples Comparability

This section discusses samples taken from the same locations and analyzed by similar methods at different laboratories. Identification of the split samples is presented in tabular format as shown in the example below.

Table 14. Split Samples

Station ID	Sample ID	Sample Interval	Date/Time Collected	Sample Type	Media	Lab
A013-02	A013-0000006	1-4	01/20/22 0950	REG	SOIL	GEL
A013-02	A013-0000007	1-4	01/20/22 0950	SPL	SOIL	TAL

3.12 Summary of Data Sensitivity Evaluation

This section summarizes the results of the data sensitivity evaluation. It applies to constituents that have a high percentage of non-detects (i.e., greater than 95% non-detect) to identify if the MDL exceeds the threshold screening criteria. The review of MDLs by matrix, method, and analyte

relative to criteria of interest is presented in tabular format in Appendix A. Non-detected results that have MDLs greater than the threshold criteria are identified below.

Table 15. Data Sensitivity Summary

Method Code	Analyte	Total # of Records with MDL Exceeding Screening Threshold
EPA 6010D	Antimony	3
	Silver	11

4.0 DATA USABILITY

This section provides a statement that indicates whether the data meets DQOs for the applicable project. In addition, a discussion of any data limitations is provided.

References

The following reference documents may be used for the development of the Data Usability Report.[1] A reference section is normally not published in the Data Usability Report.

Uniform Federal Policy for Quality Assurance Project Plans, EPA-505-B-04-900A, DOD-DTIC-ADA-427785, Intergovernmental Data Quality Task Force (U.S. Environmental Protection Agency, U.S. Department of Defense, U.S. Department of Energy), Version 1 Final, March 2005.

Area Completion Projects Programmatic Quality Assurance Project Plan for Environmental Data Collection and Management, ERD-AG-2005-00001, Revision 5, Savannah River Site, Aiken, SC, April 2012.

List of Appendices

A sample appendix to be included in the Data Usability Report is listed below.

Appendix A. Comparison of MDLs for Non-Detects to Risk-Based Screening Criteria

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation.

This page is intentionally left blank.

PERFORMANCE EVALUATION REPORT FORMAT

This document format supports the development of a Performance Evaluation Report (PER) for the remedial technology performance of operating systems to South Carolina Department of Health and Environmental Control (SCDHEC) and United States Environmental Protection Agency (USEPA). The purpose of PERs is to report remedial technology performance for remedial actions (RAs) or removal actions that involve operating remedial/removal systems (i.e., active soil vapor extraction [SVE] systems, passive BaroBall™ fields, passive SVE MicroBlower™ systems, etc.) where contaminant mass removal can be measured. Additionally, the PER may propose recommendations to enhance or eliminate components of an operating remedial/removal system to ensure cleanup levels are met. The document sections are revised as appropriate for the Operable Unit (OU)-specific reporting requirements.

1.0 INTRODUCTION

This section provides an introduction to the PER and the respective OU. This section briefly discusses the selected RA or removal action for the OU, evaluation frequency, constituents of interest, and the data collected (groundwater, surface water, etc.). The document that provides the driver for the OU performance evaluation requirements, usually the Correctives Measures Implementation Plan/Remedial Action Implementation Plan or Post-Construction Report, and the reporting requirements are referenced in this section.

This section presents OU background information such as the physical characteristics of the OU, unit-specific geologic and hydrogeologic description (if available), climatic conditions, physical setting, size and/or volume, history of operations or disposal activities, type of contaminants, and the nature and extent of contamination. Previous regulatory action taken at the OU may be discussed in this section if appropriate.

Reference to figure(s) depicting the relative location at Savannah River Site and the OU location map may be included.

2.0 REMEDIAL OR REMOVAL ACTIONS

This section presents a description of the RA(s) or removal action(s) taken at the OU, provides any operational knowledge about the OU, and provides the results of performance monitoring. A table summarizing the RA(s) or removal action(s) taken at the OU may be referenced in this section. The section is segregated into subsections, as appropriate for the OU, which may present the following information:

- A description of the current monitoring network. For example, this section may include the number of monitoring stations, type of monitoring stations, optimization of the monitoring network or deviations from the monitoring plan, data associated with the monitoring network and/or OU, and compliance details. The Conceptual Site Model, if applicable, is referenced.
- The RA or removal action operating system design and construction details, as appropriate, are briefly discussed along with a reference to the applicable design document (i.e., Removal Action Design Plan, Corrective Measures Implementation Plan/Remedial Action Implementation Plan, etc.). Figure(s) depicting the location of the operating system components, monitoring system, and OU boundary map are referenced as appropriate.
- Sampling and compliance or performance evaluation methods are presented as appropriate. The methods and calculations used to evaluate the performance of operating systems vary between OUs. Methods for sampling, calculating mass removed, etc. are discussed.
- Presentation and discussion of the compliance and performance monitoring results are provided. Performance results are presented for all active and passive operating systems for the RA or removal action. The results are compared to the RA or removal action objectives and discussed with reference to relevant time-series charts, concentration maps, tables summarizing mass removal, etc. A discussion of the contaminants of concern and the cleanup criteria that must be met in order to meet the RA or removal action objectives and/or cleanup levels is included.

3.0 CONCLUSIONS/RECOMMENDATIONS

This section provides a summary of the overall performance of the RA or removal action operating system and whether or not the objectives are being met. A discussion of the current and projected state of the remedial system (e.g., transition from active to passive technology, etc.) is provided if appropriate. The projected time period for meeting cleanup levels is discussed with the supporting rationale (e.g., groundwater model projections, data trends, etc.). In the case of an underperforming remedial system, a recommendation for shutting down the system or adding enhancements to the system will be included for further discussion with the Core Team.

If the sampling results confirm that cleanup levels have been met, a recommendation to convene the Core Team to discuss the sampling results in the context of achieving the RA or removal action objectives will be included. PERs will continue until the Core Team reaches agreement that the cleanup levels have been adequately achieved.

4.0 REFERENCES

This section provides a list of references that are referred to in the PER.

Figures and Tables

A sample list of figures and tables to be included in the PER is listed below. Figures and tables will be specific for the OU. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Geographic Proximity of the Savannah River Site
Figure 2. SRS Site Map Showing the Relative Location of the OU
Figure 3. Location of the OU/Subunits within the Area OU (if applicable)
Figure 4. Photo of OU/Subunits RA Systems
Figure 5. As Needed (e.g., location maps, groundwater monitoring wells, cross-sections, construction diagrams, performance trend plots, etc.)

Table 1. Remedial Action Description and Status
Table 2. RA Performance Requirements
Table 3. RA System Construction Details
Table 4. RA System Operation Configuration Details

Table 5. As Needed (e.g., Result Data Tables, Performance Metrics, Performance Evaluation Tables, etc.)

Appendices

Appendices are included as appropriate. Appendices may include data matrix tables presenting monitoring results, time-series plots of contaminant concentrations over time, hydrographs, etc.

EFFECTIVENESS MONITORING REPORT FORMAT

This document format supports the development of an Effectiveness Monitoring Report (EMR) for documenting the effectiveness of a remedial action (RA) or removal action. EMRs are used to report monitoring results and trending information to South Carolina Department of Health and Environmental Control (SCDHEC) and United States Environmental Protection Agency (USEPA) for remedies that do not involve operating remedial/removal systems (e.g., Monitored Natural Attenuation, in situ treatment barriers, in situ chemical oxidation, etc.) and where mass removal therefore cannot be measured. The monitoring requirements and reporting criteria are identified in an Effectiveness Monitoring Plan (EMP) or similar planning document. Provided below is a generic format for an EMR. The document sections are revised as appropriate for the Operable Unit (OU)-specific reporting requirements.

1.0 INTRODUCTION

This section provides an introduction to the EMR and OU. This section briefly discusses the selected removal action or RA for the OU and its objective(s), monitoring frequency, constituents of interest, and the data collected (groundwater, surface water, etc.). The OU-specific EMP approved by the USEPA and SCDHEC or similar planning document is referenced in this section.

2.0 OPERABLE UNIT DESCRIPTION AND HISTORY

This section presents a description of the OU and provides any operational knowledge about the OU. The section is segregated into subsections as appropriate for the OU to present the following:

- Physical characteristics of the OU such as unit-specific geologic and hydrogeologic description (if available), climatic conditions, physical setting, size and/or volume, history of operations or disposal activities, type of contaminants, and the nature and extent of contamination. Figure(s) depicting the location of the OU are referenced.
- The removal action or RA implementation and monitoring goals. A discussion of the contaminants of concern and the cleanup criteria that must be met in order to meet the removal or remedial action objectives and/or cleanup levels is included. Figure(s) depicting the location

of the monitoring system and OU boundary map are referenced as appropriate. The Conceptual Site Model, if applicable, should be referenced.

- A description of the current monitoring network is provided in this section. For example, this section may include the number of monitoring stations, type of monitoring stations, optimization of the monitoring network or deviations from the monitoring plan, data associated with the monitoring network and/or OU, and compliance details.
- The design and construction details, as appropriate, are briefly discussed along with a reference to the applicable design document (i.e., Removal Action Design Plan, Corrective Measures Implementation Plan/Remedial Action Implementation Plan, etc.).

3.0 MONITORING AND REPORTING

This section is segregated into subsections as appropriate to present the monitoring and reporting information. The topics below are examples of what may be included in an EMR, but are not all inclusive and are subject to change depending on the OU and selected RA or removal action.

- **Vadose Zone Monitoring** - Results of the vadose zone monitoring stations and soil samples are presented in applicable tables and graphs, along with discussions of the performance trends and outlooks.
- **Groundwater Monitoring Well Network** - The number of groundwater monitoring wells, zone of capture design, and overall size of the monitoring area is discussed. Monitoring station construction details may be presented in tables and/or figures in this section.
- **Groundwater Elevation Measurements and Groundwater Flow Direction** - Results of the groundwater elevation measurements, potentiometric contours, precipitation, and groundwater recharge are generated and presented here in applicable tables, graphs, and figures as needed. Discussions of the changes that have been observed and potential impacts from the removal action or RA are discussed.
- **Groundwater and Surface Water Compliance** - Details on groundwater and surface water compliance are discussed in this section. Maximum contaminant levels, key source zone contaminant levels, etc., are presented in applicable figures and tables in this section with

exceedances clearly depicted. Results from the groundwater and surface water monitoring stations are presented in applicable tables, graphs and appendices, along with discussions of the performance trends and outlooks.

4.0 SUMMARY AND RECOMMENDATIONS

This section summarizes the results included in the EMR. An overview of the data collected and a discussion comparing the results to the removal action or RA objectives and cleanup levels in order to evaluate the effectiveness of the monitoring network is included. This section provides recommendations on future monitoring or modification to the action including any future optimization of the monitoring network, future abandonment activities, and future reporting.

5.0 REFERENCES

This section provides a list of the documents that are referred to in the EMR.

Figures and Tables

A sample of the figures and tables that may be included in the EMR are listed below. Figures and tables may also be presented in appendices, if appropriate. Figures and tables will be specific for the OU.

Figure 1. Location of the Operable Unit
Figure 2. Location of the Monitoring System
Figure 3. Operable Unit Boundary Map
Figure 4. Conceptual Site Model of Operable Unit Contaminant Plume
Figure 5. Operable Unit Groundwater Model Particle Tracks
Figure 6. Plume Cross Section
Figure 7. Maximum Contaminant Concentrations

Table 1. Sampling and Reporting Schedule
Table 2. MCLs for Refined Constituents of Concern
Table 3. Groundwater and Surface Water Contaminant Trigger Levels

List of Appendices

This section identifies the appendices included in the EMR. Appendices are specific for the OU.

Appendix A. Operable Unit Monitoring Results/Data Tables

Appendix B. Operable Unit Hydrographs
Appendix C. Operable Unit Time-Series Plots
Appendix D. Contaminant Plume/Concentration Maps
Appendix E. Potentiometric Maps

REMOVAL SITE EVALUATION REPORT FORMAT

This document format supports the development of a Removal Site Evaluation Report (RSER). In accordance with Savannah River Site (SRS) Federal Facility Agreement (FFA) section X, "Site Evaluations," an RSER can be prepared for a newly discovered release site to evaluate the need for removal action or for remedial investigation and remedial action. Time-critical removal actions are implemented when the removal action must begin within 6 months in order to protect human health and/or the environment.

EXECUTIVE SUMMARY

The Executive Summary briefly summarizes the overall RSER report, results, and planned removal action or conclusion that neither removal nor remedial action is warranted. The release/potential release or operable unit (OU)/facility may be referred to FFA Appendix G for remedial site evaluation or FFA Appendix C for remedial investigation and assessment if the evaluation determines a removal action is not necessary.

1.0 INTRODUCTION

The purpose of this section is to provide the reason to evaluate the release/potential release or OU/facility for removal action or remedial investigation and assessment. The United States Department of Energy (USDOE), as lead agency, is mandated to take action to reduce the adverse effects of contamination per the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The USDOE will use the criteria established in the NCP, 40 Code of Federal Regulations (CFR) 300.415 to evaluate the release/potential release or OU/facility.

This section will also provide an introduction to the SRS. A reference to a figure showing the geographic proximity of the SRS is included.

2.0 SITE CHARACTERIZATION

2.1 Site Description and Background

The purpose of this section is to present a summary of the information available about the

release/potential release or OU/facility in order to provide a basic understanding of the physical description and history of site operations. A brief description of the release/potential release or OU/facility including its location, size, and geography is provided. The description should be clear as to whether ancillary facilities or structures are within the scope of the RSER. Maps showing general location and surrounding features are referenced. If surrounding features are included on maps, notes should be included to specify if the features are included as reference points or in the RSER scope. A reference that directs the reader to the more extensive information available in the Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation/Baseline Risk Assessment (RFI/RI/BRA) report or other Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) documentation is provided.

A brief description of the environmental setting of the release/potential release or OU/facility including the SRS watershed location and drainage features is provided. The release/potential release or OU/facility may straddle two watersheds and drain to more than one creek or artificial drainage. The surface drainage and groundwater flow and discharge is briefly discussed, as appropriate. Important features such as whether the OU/facility exists over shallow groundwater or is in close proximity to wetlands are described. A reference that directs the reader to the more extensive information about the environmental setting available in the RFI/RI/BRA report or other CERCLA documentation is included, if available.

If the OU/facility represents no historical significance, then a statement is included to explain that the OU/facility has not been identified as a structure which qualifies as historically significant as documented in the SRS's Cold War Built Environment Cultural Resource Management Plan (CRMP) if appropriate. If the OU/facility has been determined to have historical signficance, a description of the OU/facility's applicable historic property management methods or mitigation plans is provided.

2.2 Nature and Extent of Contamination

A summary of the nature and extent of contamination at the release/potential release or OU/facility is provided in this section. The characterization efforts and the results of that characterization are summarized. A brief discussion of the results of the contaminant migration analysis, human health risk assessment, and ecological risk assessment is included, if available. A reference that directs

the reader to the more extensive information available in the RFI/RI/BRA report or other CERCLA documentation is included, if available.

For time-critical removal actions, CERCLA documentation of the release/potential release or OU/facility may not be available. In that case, a discussion of the contamination and risks of SRS units with similar conditions and contamination may be appropriate to presumptively identify the problems warranting action for the release/potential release or OU/facility addressed in the RSER. A characterization report, streamlined risk assessment, and/or contaminant migration analysis may be prepared and included as appendices to the RSER if needed to support the problem warranting action.

2.3 Previous Action

A summary of any removal and/or remedial actions that have taken place at the release/potential release or OU/facility is provided in this section. Types and volume of waste produced, waste characterization reports, etc., may be appropriate to support the problem warranting action. A reference that directs the reader to more extensive information available in previous RSERs, Engineering Evaluations/Corrective Actions (EE/CAs), Early Action Proposed Plans, Records of Decisions, or other CERCLA documentation is included, if appropriate.

A statement is included in this section if no prior CERCLA actions have been implemented at the OU/facility.

3.0 RELEASE OR THREATENED RELEASE INTO THE ENVIRONMENT OF A HAZARDOUS SUBSTANCE OR POLLUTANT OR CONTAMINANT

The purpose of this section is to provide the justification for the removal action or for remedial investigation/action. As documented in the summary section, the release/potential release or OU/facility may be referred to FFA Appendix G for remedial site evaluation or FFA Appendix C for remedial investigation and assessment if the evaluation determines a removal action is not necessary.

USDOE, as lead agency, is mandated to take action to reduce the adverse effects of man-made contamination on human health and the environment. The NCP states that if the lead agency

determines a release or potential release poses a threat to public health or welfare or the environment, the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release. This determination should be based on the factors identified in 40 CFR Section 300.415(b)(2).

At least one of the factors from the following list is selected that best fits the justification for the planned removal action.

(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems.

(3) Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release.

(4) High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that might migrate.

(5) Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.

(6) Threat of fire or explosion.

(7) The availability of other appropriate federal or state response mechanisms to respond to the release.

(8) Other situations or factors that may pose threats to public health or welfare or the environment.

The problems warranting action associated with the release/potential release or OU/facility that meet the 40 CFR Section 300.415(b) (2) factor(s) selected above are provided in this section.

If a removal action is appropriate but time critical removal is not necessary, the need for a non-time critical (NTC) removal action is documented in the summary section, and an evalution of multiple alternatives is conducted in a Engineering Evaluation/Cost Analysis (refer to F-19 RSER/EE/CA Format).

If the removal action is time critical, the following sections provide a description of the planned

time-critical removal action including the estimated cost. Unlike a NTC removal action, an analysis of multiple alternatives is not needed for a time-critical response.

4.0 TIME-CRITICAL REMOVAL ACTION

This section provides a description of the planned time-critical removal action and how it meets the criteria to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release.

4.1 Applicable or Relevant and Appropriate Standards

The purpose of this section is to identify the applicable or relevant and appropriate requirements (ARARs) and to-be-considered (TBC) guidance that is associated with the planned time-critical removal action. In accordance with 40 CFR § 300.415(j) of the NCP, on-site removal actions conducted under CERCLA shall to the extent practicable attain ARARs under Federal environmental or State environmental or facility siting laws. In determining whether compliance with ARARs is practicable, the lead agency may consider appropriate factors, including 1) the urgency of the situation; and 2) the scope of the removal action. ARARs include only Federal and State environmental or facility siting laws/regulations; they do not include occupational safety or worker protection requirements. The NCP allows a removal action to be selected that does not meet an ARAR under certain specific circumstances in 40 CFR 300.430(f)(1)(ii)(c).

An ARAR table is provided and referenced in this section.

4.2 National Environmental Policy Considerations

The purpose of this section is to confirm that the RSER conforms to USDOE policy (i.e., DOE Order 451.1B, "National Environmental Policy Act Compliance Program") to incorporate National Environmental Policy Act Compliance Program (NEPA) values in USDOE CERCLA documents. NEPA values include consideration of socioeconomic, ecological, off-site, and cumulative impacts to the extent practicable. If NEPA values were addressed in previous CERCLA documentation, the document (i.e., RFI/RI/BRA, Corrective Measures Study/Feasibility Study, or other CERCLA documentation) is referenced and the details are summarize in the RSER.

For time-critical removal actions, CERCLA documentation of the release/potential release or

OU/facility may not be available. In that case, a discussion of the contamination and risks of SRS units with similar conditions and contamination may be appropriate. The time-critical removal action is assessed against its impact on the following NEPA values.

- Socioeconomics and demographics;
- Environmental justice;
- Archeological, historical, and cultural resources;
- Natural resources;
- Protected plant and animal species;
- Floodplains and wetlands; and
- Cumulative impacts

The cumulative adverse impacts associated with the time-critical removal action are summarized and discussion is included whether or not the removal action would have a significant or negligible contribution to an overall cumulative adverse effect on- or off-SRS. In most cases, the cumulative impacts would be so small that their potential contribution to an overall cumulative effect on- or offsite would be negligible.

5.0 COST

The purpose of this section is to present the estimated costs associated with the time-critical removal action and to reference the cost estimate table.

6.0 SUMMARY

The purpose of this section is to summarize why removal action is appropriate to meet a short-term response, or why referring the release/potential release or OU/facility to FFA Appendix C or Appendix G of the for remedial assessment is appropriate. Justification to explain that a delay in action or no action would increase the actual or potential threats to human health and/or the environment is provided. The removal action will be conducted in accordance with CERCLA, as

amended, and is consistent with the NCP. The RSER can also conclude that neither removal nor remedial action is warranted.

7.0 PROJECT SCHEDULE

The purpose of this section is to provide the project schedule for the RSER. The RSER will be submitted to U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) for review and comment/concurrence prior to the removal action start. The RSER will be available for 30-day public comment period no later than 60 days following the start of the removal action activity.

An Action Memorandum (AM) is prepared for submittal to the regulatory agencies and the public that documents the need for a CERCLA removal action, identifies the action and cleanup levels (if applicable), and explains the rationale for the removal response. The AM is the primary decision document selecting a removal response. For time critical removals, it may not be feasible to complete the AM prior to start of the remedial action[1].

A typical schedule for a time-critical removal action is provided below. The order of activities may be different than shown below based on regulatory discussions and project requirements.

Submit Revision 0 RSER and Draft AM for Regulatory Review and Comment	Month, Day, Year
Submit Revision 1 RSER & Comment Responses and Revised Draft AM for Regulatory Review and Concurrence	Month, Day, Year
Removal Action Start	Month, Day, Year
Submit Final AM and RSER to USEPA and SCDHEC	Month, Day, Year
Issue Final AM and RSER for Public Comment	Month, Day, Year
Submit Revision 0 Removal Action Report for Regulatory Comment	Month, Day, Year
Submit Revision 1 Removal Action Report and Comment Responses for Regulatory Concurrence	Month, Day, Year

[1] For a NTC removal action, the EE/CA documents the appropriateness of a removal action which is then chosen in the AM after the EE/CA and public comment period.

8.0 REFERENCES

This section provides a list of the documents that are referred to in the RSER and may include the following reference document.[2]

Removal Actions Under CERCLA, Office of Environmental Restoration Regulatory Integration Division (EM-431), Office of Environmental Guidance RCRA/CERCLA Division (EH-231), U.S. Department of Energy, Washington, D.C., September 1994.

Figures and Tables

A sample of the figures and tables that may be included in the RSER are listed below. Figures and tables will be specific for the OU/facility. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Geographic Proximity of the Savannah River Site
Figure 2. SRS Site Map Showing the Relative Location of the OU/Facility
Figure 3. Location of the OU/Facility within the Area OU (if applicable)
Figure 4. Photo of OU/Facility
Figure 5. As Needed (e.g., groundwater monitoring wells, cross-sections, cover systems, etc.)

Table 1. Removal Action Cleanup Levels
Table 2. Potential ARARs and TBC Criteria for the OU/Facility
Table 3. Cost Estimates

Appendices

Appendices are included as appropriate. Appendices may include characterization reports, waste characterization reports, Sampling and Analysis Plans, comparison of data to threshold values, etc.

[2] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation

REMOVAL SITE EVALUATION REPORT/ENGINEERING EVALUATION/ COST ANALYSIS FORMAT

This document format supports the development of a Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis (RSER/EE/CA) for a non-time critical (NTC) removal action. NTC removal actions are implemented when a planning period of 6 months or more after issuance of the Action Memorandum (AM) is available without causing further threat to human health and/or the environment.

A combined RSER/EE/CA is developed when the need for a NTC removal action is already recognized by the Core Team. The RSER portion describes the basis for taking a response action (i.e., the problem warranting action); the EE/CA portion describes the objectives of the NTC removal action and comparatively evaluates alternatives for achieving them. Unlike the combined RSER/EE/CA, a stand-alone RSER (see F-18 RSER Format) is developed to determine whether removal action, remedial action, or no response action is appropriate for a release/potential release or operable unit (OU)/facility.

EXECUTIVE SUMMARY

The Executive Summary briefly summarizes the overall RSER/EE/CA report, results, basis for response action, and the recommended NTC removal action alternative.

1.0 INTRODUCTION

The purpose of this section is to provide an introduction to the release/potential release or OU/facility evaluated in the RSER/EE/CA and to the Savannah River Site (SRS). The United States Department of Energy (USDOE), as lead agency, is mandated to take action to reduce the adverse effects of contamination per the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The USDOE will use the criteria established in the NCP, 40 Code of Federal Regulations (CFR) 300.415 to evaluate the release/potential release or OU/facility. This section will also explain how the public can participate in the review of the document (i.e., copies

available in reading rooms, libraries, and SRS Public Involvement contact information). A reference to a figure showing the geographic proximity of the SRS is included.

2.0 SITE CHARACTERIZATION

2.1 Site Description and Background

The purpose of this section is to present a summary of the information available about the release/potential release or OU/facility to provide a basic understanding of the physical description and history of site operations. A brief description of the release/potential release or OU/facility including its location, size, and geography is provided. The description should be clear as to whether ancillary facilities or structures are within the scope of the RSER/EE/CA. Maps showing general location and surrounding features are referenced. If surrounding features are included on maps, notes should be included to specify if the features are included as reference points or in the RSER/EE/CA scope. A reference that directs the reader to the more extensive information available in the Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation/Baseline Risk Assessment (RFI/RI/BRA) report or other comprehensive Environmental Response, Compensation and Liability Act (CERCLA) documentation is provided.

A brief description of the environmental setting of the release/potential release or OU/facility including the SRS watershed location and drainage features is provided. The release/potential release or OU/facility may straddle two watersheds and drain to more than one creek or artificial drainage. The surface drainage and groundwater flow and discharge is briefly discussed, as appropriate. Important features such as whether the release/potential release or OU/facility exists over shallow groundwater or is in close proximity to wetlands are described. A reference that directs the reader to the more extensive information about the environmental setting available in the RFI/RI/BRA report or other CERCLA documentation is included, if available.

If the OU/facility represents no historical significance, then a statement is included to explain that the OU/facility has not been identified as a structure which qualifies as historically significant as documented in the SRS's Cold War Built Environment Cultural Resource Management Plan (CRMP) if appropriate. If the OU/facility has been determined to have historical significance, a

description of the OU/facility's applicable historic property management methods or mitigation plans is provided.

2.2 Previous Action

A summary of any removal and/or remedial actions that have taken place at the release/potential release or OU/facility is provided in this section. Types and volume of waste produced, waste characterization reports, etc., may be appropriate to support the problem warranting action. A reference that directs the reader to more extensive information available in previous RSERs, RSER/EE/CAs, Early Action Proposed Plans, Records of Decisions, or other CERCLA documentation is included, if appropriate.

A statement is included in this section if no prior CERCLA actions have been implemented at the OU/facility.

2.3 Land Use

A summary of the current and future land use for the OU/facility is provided. Nearly all SRS sites will be identified for future industrial land use. Most OUs/facilities located in Area Closure OUs will be in industrial areas with no ecological habitat. OUs/facilities located outside industrial area fences will likely need an ecological risk assessment. An explanation that any future land use will be controlled by the SRS Land Use Control Assurance Plan (LUCAP) is included. Appropriate figure(s) showing location of OU/facility within the industrial area, perimeter fence line of an Area OU, etc., are referenced.

A statement is included to clarify that groundwater is/is not part of the OU/facility or Area OU. If groundwater is not part of the OU/facility addressed by the RSER/EE/CA, the OU that the groundwater is part of is identified. A statement is included that there is no current or projected future use of the groundwater as a drinking water source.

2.4 Nature and Extent of Contamination

A summary of the nature and extent of contamination at the release/potential release or OU/facility is provided in this section. The characterization efforts and the results of that characterization are summarized. A brief discussion of the results of the contaminant migration analysis, human health

risk assessment, and ecological risk assessment is included, if available. A reference that directs the reader to the more extensive information available in the RFI/RI/BRA report or other CERCLA documentation is included, if available. A concise statement of the basis for the response action (i.e., problem warranting action) is documented in this section.

If no previous CERCLA documentation is available, an evaluation of the existing data that is sufficient to demonstrate a need for action is included. A characterization report, a streamlined risk assessment, and/or a contaminant migration analysis may be prepared and included as appendices to the RSER/EE/CA, if necessary. A reference to the release/potential release or OU/facility conceptual site model is included in this section.

3.0 REMOVAL ACTION SCOPE AND OBJECTIVES

The purpose of this section is to identify the contaminated media to be addressed by the NTC removal action including a discussion of the scope of the problem (volume, area, depth, etc., that needs clean up). A sampling plan per 40 CFR 300.415 (4)(ii) for the collection of data to support the planning activities for the NTC removal action may be submitted, as appropriate. The sampling plan should be referenced in the RSER/EE/CA but submitted as a separate document. A statement is included in this section if no confirmatory sampling is needed.

3.1 Justification for the Preferred Removal Action

The justification for the preferred NTC removal action is provided in this section. A statement is included that the United States Department of Energy (USDOE), as lead agency, is mandated to take action to reduce the adverse effects of man-made contamination on human health and/or the environment. The NCP states that if the lead agency determines a release or potential release poses a threat to public health or welfare or the environment, the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release. This determination should be based on the factors identified in 40 CFR Section 300.415(b)(2). At least one of the factors from the following list that best fits the justification for the proposed removal action is selected.

1. Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.
2. Actual or potential contamination of drinking water supplies or sensitive ecosystems.
3. Hazardous substances or pollutants or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release.
4. High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that might migrate.
5. Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released.
6. Threat of fire or explosion.
7. The availability of other appropriate federal or state response mechanisms to respond to the release.
8. Other situations or factors that may pose threats to public health or welfare or the environment.

The problems warranting action associated with the release/potential release or OU/facility that meet the 40 CFR Section 300.415(b) (2) factor(s) selected above are provided in this section.

3.2 Removal Action Objectives

The NTC removal action objective(s) for human health receptors, ecological receptors, contaminant migration, and/or groundwater are provided in this section in a bulleted format. The anticipated end state for the release/potential release or OU/facility is identified in this section.

4.0 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

This section provides a description of the NTC removal action alternatives evaluated. A minimum of 3 alternatives (and no more than 7 alternatives) are screened in the RSER/EE/CA. Each NTC removal action alternative is identified in bulleted format with a brief description for each. Alternative 1 is always a No Action alternative as required by the NCP for evaluation as a baseline condition.

5.0 ANALYSIS AND COMPARISION OF REMOVAL ACTION ALTERNATIVES

The number of NTC removal action alternatives presented in this RSER/EE/CA for evaluation is stated. An evaluation of each NTC removal action alternative against the three broad criteria of effectiveness, implementability, and cost as recommended under CERCLA for NTC removal actions is provided. In addition, the applicable or relevant and appropriate standards (ARARs) that are associated with each NTC removal action alternative are provided.

5.1 Effectiveness

The purpose of this section is to evaluate each NTC removal action alternative against the effectiveness criteria (i.e., overall protection of human health and environment, long-term effectiveness and permanence, reductions in toxicity, mobility, and volume through treatment, and short-term effectiveness). A brief description of how the NTC removal action alternative does or does not provide overall protection to human health and/or the environment is provided. For the No Action alternative, an explanation is included that this alternative does not meet the effectiveness criteria because leaving contaminants in place does not reduce the risk to future human receptors, ecological receptors, and/or groundwater and does not provide overall protection to human health and/or the environment. This section identifies whether or not each alternative contributes to a reduction of toxicity, mobility, or volume through treatment.

5.1.1 Identification of Applicable or Relevant and Appropriate Standards

The purpose of this section is to identify the ARARs and to-be-considered (TBC) guidance that are associated with each NTC removal action alternative. Compliance with ARARs and TBCs is a measure of the effectiveness of the removal action alternatives in the protection of human health and the environment. USDOE, the lead agency at the SRS, is expected to comply with ARARs and TBC guidance as set forth in the RSER/EE/CA when conducting this NTC removal action.

Each NTC removal action alternative is evaluated against the appropriate chemical-, location-, and action-specific ARAR. An ARAR table located in the appendices that identifies the ARARs associated with each NTC removal action alternatives is referenced. A statement on whether the RSER/EE/CA does/does not propose to waive any ARARs is included.

5.2 Implementability

The purpose of this section is to evaluate each NTC removal action alternative against the implementability criteria for the following:

- Technical feasibility with regard to available techniques and demonstrated methods for accomplishing each alternative.
- Administrative feasibility with regard to available resources including personnel, equipment, material, and appropriate technology.
- Regulatory acceptance of each alternative.
- Community acceptance of the proposed alternative. USDOE–Savannah River will provide for a public comment period, and comments concerning the proposed remedy will be incorporated into the comment responses and included with the Action Memorandum.

5.3 Cost

The purpose of this section is to present the estimated costs associated with each NTC removal action alternative for the purpose of comparing the alternatives and to reference the cost estimate analysis in the appendices. A brief summary of the assumptions that form the basis of the cost estimate is provided.

5.4 Comparison of Removal Action Alternatives

The purpose of this section is to provide a comparative analysis of the NTC removal action alternatives in tabular format similar to the table below with a ranking of low, medium, or high for each criterion.

	Effectiveness	**Implementability**	**Cost**	**Acceptance**
Alternative 1 No Action	Low	Low/Medium/High	$ 0	Low/Medium/High
Alternative 2 OU/facility-specific remedy	Low/Medium/High	Low/Medium/High	$ xx M	Low/Medium/High
Alternative 3 OU/facility-specific remedy	Low/Medium/High	Low/Medium/High	$ xx M	Low/Medium/High
Alternative X OU/facility-specific remedy	Low/Medium/High	Low/Medium/High	$ xx M	Low/Medium/High

Note: Range is Low to High, where Low = worst and High = best.

6.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

The purpose of this section is to identify the recommended NTC removal action alternative and discuss why it is the recommended alternative. A brief discussion of how the recommended alternative meets the effectiveness criteria to protect human health and the environment, is implementable, is cost effective, and meets necessary ARARs when compared to the other alternatives is provided. A statement is included whether or not cumulative adverse impacts associated with the recommended NTC removal action would have a significant or negligible contribution to an overall cumulative adverse effect on- or off-SRS. A statement is also included to clarify whether or not the recommended NTC removal action would preclude additional remediation and is consistent with the current and future land use.

7.0 NATIONAL ENVIRONMENTAL POLICY CONSIDERATIONS

The purpose of this section is to confirm that this RSER/EE/CA conforms to USDOE policy (i.e., DOE Order 451.1B, "National Environmental Policy Act Compliance Program") to incorporate National Environmental Policy Act (NEPA) values in USDOE CERCLA documents. NEPA values include consideration of socioeconomic, ecological, off-site, and cumulative impacts to the extent practicable. If NEPA values were addressed in previous CERCLA documentation, reference the document (i.e., RFI/RI/BRA, Corrective Measures Study/Feasibility Study, or other CERCLA documentation) and summarize the details in the RSER/EE/CA. If no previous CERCLA documentation is available, a reference to the characterization report, streamlined risk assessment, and/or contaminant migration analysis included in the appendices is included, as appropriate.

The recommended NTC removal action alternative is assessed against its impact on these resources and other values. NEPA values that should be addressed in most evaluations include the following:

- Socioeconomics and demographics;
- Environmental justice;
- Archeological, historical, and cultural resources;
- Natural resources;

- Protected plant and animal species;
- Floodplains and wetlands; and
- Cumulative impacts

The cumulative adverse impacts associated with the recommended NTC removal action are summarized and a statement is included whether or not the NTC removal action would have a significant or negligible contribution to an overall cumulative adverse effect on- or off-SRS. In most cases, the cumulative impacts would be so small that their potential contribution to an overall cumulative effect on- or offsite would be negligible.

8.0 PROJECT SCHEDULE

The purpose of this section is to provide the estimated project schedule for the RSER/EE/CA. The RSER/EE/CA will be submitted to U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) for review and comment/concurrence followed by a 30-day public comment period. After the end of the public comment period, the AM and Responsiveness Summary will be submitted to USEPA and SCDHEC for their files. The final AM and Responsiveness Summary will be issued to the public prior to the start of the removal action. The AM is the primary decision document selecting a removal response and documents the need for a CERCLA removal action, identifies the action and cleanup levels (if applicable), and explains the rationale for the removal response.

Submit Revision 0 RSER/EE/CA for Regulatory Comment	Month, Day, Year
Submit Revision 1 RSER/EE/CA & Comment Responses to USEPA and SCDHEC for Concurrence and the Draft AM for Regulatory Review and Comment	Month, Day, Year
Issue RSER/EE/CA for Public Comment	Month, Day, Year
Submit AM and Responsiveness Summary to USEPA and SCDHEC	Month, Day, Year
Issue AM and Responsiveness Summary for Public Notice	Month, Day, Year
Submit Revision 0 Removal Action Design Plan (RADP) for Regulatory Comment	Month, Day, Year

Submit Revision 1 RADP and Comment Responses for Regulatory Approval	Month, Day, Year
Removal Action Start	Month, Day, Year
Submit Revision 0 Removal Action Report for Regulatory Comment	Month, Day, Year
Submit Revision 1 Removal Action Report & Comment Responses for Regulatory Approval	Month, Day, Year

9.0 REFERENCES

This section provides a list of the documents that are referred to in the RSER/EE/CA and may include the following reference documents.[1]

Conducting Non-Time Critical Removal Actions Under CERCLA, OSWER Directive 9360.0-32, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., December 1993.

Removal Actions Under CERCLA, Office of Environmental Restoration Regulatory Integration Division (EM-431), Office of Environmental Guidance RCRA/CERCLA Division (EH-231), U.S. Department of Energy, Washington, D.C., September 1994.

Figures and Tables

A sample of the figures and tables that may be included in the RSER/EE/CA are listed below. Figures and tables will be specific for the release/potential release or OU/facility. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Geographic Proximity of the Savannah River Site
Figure 2. SRS Site Map Showing the Relative Location of the OU/Facility
Figure 3. Location of the OU/Facility within the Area OU (if applicable)
Figure 4. Photo of OU/Facility
Figure 5. Conceptual Site Model of the OU/Facility
Figure 6. As Needed (Groundwater monitoring wells, cross-sections, cover systems, etc.)

Table 1. Removal Action Cleanup Levels
Table 2. Potential ARARs and TBC Criteria for the OU/Facility

[1] Document formats included in the EC&ACP Regulatory Document Handbook are specific for the SRS FFA program and take into consideration available guidance materials and Core Team (i.e., USEPA, SCDHEC, and USDOE) agreements on regulatory documentation

Table 3. Cost Estimates

Appendices

Appendices are included as appropriate. Appendices may include characterization reports, waste characterization reports, Sampling and Analysis Plans, comparison of data to threshold values, cost estimate analysis, etc.

This page is intentionally left blank.

REMOVAL ACTION DESIGN PLAN FORMAT

A Removal Action Design Plan (RADP) is prepared for releases or operable units (OU)/facilities for a non-time critical (NTC) removal action. Documentation of the removal action will be via an eventual Post Construction Report (PCR) or PCR/Corrective Measures Implementation Report (CMIR)/Remedial Action Completion Report (RACR). RADPs are usually not prepared for time-critical removal actions because the response requires implementation of the remedial action within 6 months.

1.0 GENERAL DESCRIPTION

1.1 Purpose and Scope

The purpose of this section is to describe the plan for implementing the removal action that was selected in the Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis (RSER/EE/CA). The RADP presents the design details for the removal action including descriptions of the removal action construction strategy, removal action activities, and design drawings. Items that are addressed in the RADP include the following:

- A brief description of the release or OU/facility
- Details of the removal action design
- Permitting requirements (if applicable)
- A description of the construction strategy
- Requirements for health and safety, waste management, contamination control, decontamination, quality assurance (QA), quality control (QC) inspections, removal action verifications (sampling, testing/analysis, when applicable), post-construction operations and maintenance (when applicable), land use, and a forecast schedule for implementation of the removal action

1.2 General Description and History

The general description includes the location, size, and background operational history of the release or OU/facility. The section may also include a short paragraph identifying the predecessor documents related to the selection of the removal action. Figures showing the removal action location at Savannah River Site (SRS) and a removal action site layout are provided. A condensed summary describing the constituents of concern, associated risks, and removal action boundaries (area and depths) is provided in this section since the same information has been covered in greater detail in the RSER/EE/CA.

1.3 Regulatory Documentation

Reference to and a brief description of any regulatory documentation that has already been prepared (e.g., RSER/EE/CA, Action Memorandum, etc.) is provided.

2.0 REMOVAL ACTION DESIGN

2.1 Design Summary and Strategy

The purpose of this section is to provide a brief summary of the removal action design. In addition, a description of the removal action design strategy (e.g., identification of definitive design, performance-based design, vendor supplied design, multi-phased design, etc.) is provided.

2.2 Design Activities

A list of design tasks, including development of the permit applications required to implement the selected removal action is provided. Any design activity that was performed to complete the definitive design, e.g., treatability studies, bench-scale grout mix design, etc., is also described.

2.3 Design Criteria

Functional requirements and design criteria based on United States Department of Energy (USDOE) Orders, national consensus standards, SRS requirements, and regulatory requirements needed to ensure the design meets removal action objectives and cleanup levels per the RSER/EE/CA are provided. A table of applicable or relevant and appropriate requirements (ARARs) which includes the ARAR type, citation, status, a brief descriptive summary of what the

ARAR requires, and a brief explanation for inclusion of the ARAR is also provided. The list of ARARs will include those in the RSER/EE/CA that are related to the selected removal action and any additional ARARs identified during the design process.

2.4 Results of Data Acquisition

2.4.1 Evaluation of Studies

A summary level description of any study performed, including the application of the results and conclusion from the study to the removal action design, is provided.

2.4.2 Other Design Data

Results of any data gathered to support the removal action design (e.g., sampling, topographic, or other surveys) are provided.

2.5 Drawings

A list and brief description of the design drawings developed during the removal action design are provided.

2.6 Surveys

Survey results or planned surveys required to implement the removal action design are discussed.

2.7 Site Preparation

The purpose of this section is to describe the planned activities associated with preparing the site for implementation of the removal action. Site preparation activities may include earthwork, clearing and grubbing, installation of erosion control measures, etc.

3.0 PERMITTING REQUIREMENTS

The purpose of this section is to identify and describe all permitting activities required for the selected removal action. The related schedule for each applicable regulatory permit submittal is also included. A copy of permit documents, which are approved by other departments or

authorized representatives of U.S. Environmental Protection Agency (USEPA) or South Carolina Department of Health and Environmental Control (SCDHEC) (e.g., Stormwater Management and Sediment Reduction Plans, Monitoring Well Program Plans, Air Quality Control Permits) may be provided for reference.

4.0 CONSTRUCTION

4.1 Construction Strategy

A brief description of the construction strategy (e.g., discussion of construction in phases, construction by subcontractor, construction using new technology, etc.) for implementation of the removal action design is provided.

4.2 Construction Activities

A summary of the conceptual construction activities that are critical for implementation of the removal action is provided. Unless such activities have been concurred with by the constructor, they are considered conceptual (anticipated based on past experiences) at this stage.

4.3 Removal Action Design Change Control

The purpose of this section is to provide a standard procedure for documenting and reporting changes to the removal action design during construction activities. The following statement (or similar words with the same intent) should be included in this section.

> *"USDOE will notify USEPA and SCDHEC, within a reasonable time frame, when significant problems arise with any aspect of the removal action design or process. In particular, scheduling, budget and implementability/technical issues should be brought to the attention of the regulators as soon as they are identified. Notifications will follow established protocols for major and minor changes during construction."*

Minor changes may include schedule changes due to weather, final elevation changes that will be documented on as-built drawings, etc. Major changes are considered changes that would significantly alter the configuration of the original design and are summarized in the Removal

Action Report (RAR). USEPA and SCDHEC will be notified before any major change is initiated in the field.

4.4 Waste Disposal and Transport

Details consistent with the unit's waste management plan that will be used for waste characterization (e.g., testing methods), disposal (include location of the facility), and transportation (include contaminant limits) during construction, as applicable to the selected removal action are provided. The status of any permit required for handling, disposing and transporting wastes is also provided.

4.5 Quality Assurance

A summary of quality assurance (QA) and quality control (QC) procedures that will be implemented to ensure successful implementation of the removal action is provided. Unique or OU/facility-specific strategies applicable to the removal action are also provided. If applicable, QC inspections will ensure conformance to the specific requirements and acceptance criteria. A summary of the QC tests and inspections are provided in the RAR.

4.6 Non-Conformances

The anticipated steps and procedures that will be used to resolve construction non-conformances with respect to the required acceptance criteria in the specifications are provided. This section also provides a description of the contingency plan to be used during this construction phase if construction activities cannot be completed as designed.

4.7 Health and Safety Plan

Health and safety requirements, consistent with SRS procedures, that will be implemented during the removal action are provided. This section includes any special or OU/facility-specific requirements for worker safety during construction. The following text will be included in the RADP.

"A Site-Specific Health and Safety Plan (HASP) will be prepared in accordance with 29 CFR, Part 1910, Section 120, Occupational Safety and Health Administration (OSHA) and will be implemented by the construction team. The HASP will be approved in accordance with SRS procedures, and a copy will be available at the jobsite at all times. A copy of the HASP will also be available in the Environmental Compliance and Area Completion Projects project file.

The plan will describe the following:

- *Dust suppression requirements related to 40 CFR 50.6 and South Carolina Regulation 61-62.6*
- *Required actions by the facility personnel in case of fires, explosions, or any unplanned releases of hazardous waste*
- *Arrangements with onsite security, fire department, medical facility, and emergency response teams to coordinate emergency services*
- *Names, addresses, and phone numbers (office and home) of all persons qualified to act as emergency coordinators*
- *Emergency equipment available at the facility*
- *Evacuation plan for facility personnel"*

5.0 POST CONSTRUCTION

5.1 Post-Construction Monitoring

The purpose of this section is to describe the long- and short-term actions that will be required to monitor the effectiveness of the implemented removal action (e.g., groundwater monitoring). Details including type of sampling, sampling frequency, criteria, and reporting information will be provided, as well as maps showing the location of the removal action and zone of influence. In addition, a map showing the general grid coordinates of the removal action will be provided. If appropriate, the criteria for turnover to the next removal action phase is discussed in this section.

5.2 Contingency Plan Implementation Strategy

Contingencies after completion of construction, including any special or OU/facility-specific responses and actions to be taken if the implemented removal action fails to perform, are provided.

5.3 Operations, Maintenance, and Land Use Control

If appropriate, start-up and operational procedures for equipment and process systems required by the selected removal action are provided. This section also provides maintenance and land use control information, if appropriate. In addition, it includes any special or OU/facility-specific requirements applicable to the selected removal action.

5.4 Requirements for Project Closeout

Field data collection and performance verification requirements (including sampling, analysis, and testing plans, when applicable) and procedures to verify that the removal action objectives have been met will be provided. This section also addresses updating the design documents as required for configuration management to incorporate design changes during construction.

5.5 Schedule for Post Remedial Action Deliverables

A submittal schedule for the RAR, as well as any post-construction monitoring reports, is provided if known.

6.0 REFERENCES

This section provides a list of the documents that are referred to in the RADP.

Figures and Tables

A sample of the figures and tables that may be included in the RADP are listed below. Figures and tables may also be presented in appendices. Figures and tables will be specific for the OU/facility.

Figure 1. Location of the OU/Facility within the Savannah River Site
Figure 2. Post-Removal Action Conceptual Site Model
Figure 3. Post-Removal Action Implementation Schedule

Figure 4. Map(s) as Referenced in the Document

Table 1. Chronology of Events
Table 2. Compliance with ARARs for the Selected Removal Action

List of Appendices

Appendices and attachments are included as appropriate. Appendices are tables, charts and other information that are not stand-alone documents.

Attachments are stand-alone documents with document numbers. Examples of attachments are engineering design drawings and plans and vendor-supplied design drawings and plans. Documents such as construction and fabrication documents will not be included.

REMOVAL ACTION REPORT FORMAT

A Removal Action Report (RAR) is prepared for releases or operable units (OU)/facilities where a removal action was completed. A RAR is not required per the United States Environmental Protection Agency (USEPA) or South Carolina Department of Health and Environmental Control (SCDHEC) regulations but will be prepared for removal actions performed at Savannah River Site (SRS). Documentation of the removal action will be via an eventual Post Construction Report (PCR) or PCR/Corrective Measures Implementation Report (CMIR)/Remedial Action Completion Report (RACR). Discussion in the RAR is specific for a time-critical removal action or non-time critical (NTC) removal action.

1.0 GENERAL DESCRIPTION

1.1 Purpose and Scope

The purpose of the RAR is to document the implementation of the removal action for the release or OU/facility. Reference to the Removal Site Evaluation Report (RSER) for a time-critical removal action or to the Removal Site Evaluation Report/Engineering Evaluation/Cost Analysis (RESER/EE/CA) and the Removal Action Design Plan (RADP) for a NTC removal action as the requirements of the removal action is included.

Items that will be addressed in the RAR, as appropriate for time-critical removal action or NTC removal action, include the following:

- A brief description of the release or OU/facility background including removal action requirements and objectives
- A chronology of completed events related to remediation of the release or OU/facility
- A summary of construction activities performed
- Deviations from the original design per the RADP

- Performance standards and quality control inspections, including a summary of performance test results documenting verification of compliance with the acceptance criteria in the RADP
- Verification of construction completion
- As-built drawings
- Forecasts of post-construction activities (e.g., startup tests, operation and maintenance) per the CMIP/RAIP and the ROD (as appropriate)
- Project costs

1.2 Operable Unit Background

Since earlier documents have provided the same information in detail, the RAR provides a brief description of the release or OU/facility with emphasis on removal action requirements, including whether the OU/facility is a Resource Conservation and Recovery Act (RCRA) and/or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) unit. A location figure is included.

If a release is not part of an OU and will require no further remedial investigation or action under the SRS Federal Facility Agreement (FFA) (e.g., a newly discovered waste site cleaned up to unrestricted exposure/use levels by the removal action), an explanation in the background section is provided. If the release requires further investigation and action under the FFA following implementation of the removal action, a discussion is included to explain how the release will be incorporated into the FFA.

1.2.1 General Description and Location

This section provides a general description of the release or OU/facility. Since the RSER or RSER/EE/CA provide the same information in detail, the RAR includes a brief description of the release or OU/facility with emphasis on removal action requirements. If the OU is represented by subunits for evaluation purposes, the subunits and associated media addressed by the removal action are introduced. A location figure is included.

1.2.2 Nature and Extent of Contamination

This section briefly describes the hazardous substances, pollutants, or contaminants within the respective media of concern (i.e., soil, sediment, groundwater, etc.) as identified in the RSER or RSER/EE/CA for the removal action. The associated risks, specific components of the release or OU/facility requiring remediation, and locations of contaminants with respect to the removal action boundaries (areas and depths), is provided. Because the information is covered in greater detail in the RSER or RSER/EE/CA, a condensed presentation (synopsis or summary) is provided in this section. Figures or maps to illustrate the nature and horizontal and vertical extent of contaminants within the respective media of concern and area(s) targeted for the removal action are referenced.

1.3 Removal Action Requirements and Objectives

1.3.1 Removal Action Objectives

The removal action objectives (RAOs) for the OU/facility as stated in the RSER or RSER/EE/CA are provided in this section.

1.3.2 Selected Removal Action

The specific elements of the selected removal action for the release or OU/facility as described in the RSER or RSER/EE/CA are provided in this section.

1.4 Chronology of Events

A tabular summary is provided that lists major milestones and dates related to the removal action for the release or OU/facility starting with the Action Memorandum issuance (e.g., removal action start/mobilization, site preparation, stabilization, soil cover installation, final inspection, etc.), any major changes from the RSER or RSER/EE/CA (e.g., change in technology, change in removal action, etc.) where it was necessary to obtain regulatory concurrence or modify the Action Memorandum, demobilization, and final inspection of completed construction.

2.0 CONSTRUCTION ACTIVITIES

The purpose of this section is to provide a summary of construction activities performed during the construction phase. Subsections may be used to present the information. The names and roles of prime subcontractors associated with the removal action in addition to a brief narrative following the sequence of activities listed in Section 1.4 are included. The narrative should describe any treatment process required to implement the removal design, materials and equipment used, construction activities (e.g., surveying, land clearing, stormwater pollution prevention, erosion control, fill material, etc.), successes and problems encountered during construction and resolution of problems (including innovative solutions, if any), and causes for delay. Brief discussions of unexpected conditions encountered in the field, particularly those that affected the scope or schedule of the construction work, should also be included.

Details of the release or OU/facility waste management plan including a description of the waste types, waste volumes, characterization methods, (e.g., testing methods), disposal and transportation (include contaminant limits) during construction, as applicable to the selected removal action, are provided.

3.0 DEVIATIONS FROM ORIGINAL DESIGN

This section identifies design changes from the RADP required during construction as well as the technical basis for those changes. The discussion includes all changes made during construction, regardless of whether those changes were previously communicated to SCDHEC and USEPA. The process and scope of design change notifications are discussed in the RADP.

A table providing a summary of all design changes, along with the basis and resolution of deviations from the original design, may be provided. Where applicable, a statement on whether the deviation still meets a performance criterion is included.

4.0 VERIFICATION SAMPLING, TESTING AND ANALYSIS, PERFORMANCE STANDARDS, AND CONSTRUCTION QUALITY CONTROL

The purpose of this section is to provide the appropriate reference to the performance requirements (acceptance criteria) as required per the RADP. The performance requirements are derived from the RAOs in the RSER/EE/CA for the removal action and the construction quality control requirements. If applicable, a brief discussion of collection of test samples, a comparison of test results with those acceptance criteria, and a description of how those criteria were met is included. Non-conforming conditions identified during the quality control inspection and how those non-conformances were resolved to meet the specified performance criteria are discussed.

5.0 VERIFICATION OF CONSTRUCTION COMPLETION AND FINAL INSPECTION

5.1 Verification of Construction Completion

This section provides a discussion of how construction activities required for the removal action have met the acceptance criteria established in the RADP. If applicable, a summary of the results of the analytical sampling and testing is included and the data is either included in an appendix or the text indicates that the records are being maintained at SRS.

5.2 Final Inspection

The purpose of this section is to document the final walkdown inspection by the U.S. Department of Energy and SRS personnel (USEPA and SCDHEC may also participate) and to document deficiencies/no deficiencies observed with the completed field activities for the removal action.

6.0 AS-BUILT DRAWINGS

6.1 As-Built Drawings

If as-built drawings are available for the project, the drawings will be included in an appendix of the RAR.

6.2 Well Modifications

This section provides a summary or identifies an appendix where reports of any well modifications (e.g., well abandonment, well extension, well protection, etc.) are located.

7.0 POST-CONSTRUCTION ACTIVITIES

The purpose of this section is to provide a forecast schedule with reference to the RADP (if appropriate) for discussion of scope and content. Reference to subsequent CERCLA documents (e.g., the PCR, PCR/CMIR/RACR) to report completion of post-construction activities required by long-term RAs for the final closure of the OU/facility will be included.

8.0 PROJECT COSTS

A table comparing the final costs of the removal action activities completed in the construction phase to the original RSER or RSER/EE/CA cost estimate is provided in this section. Cost deviations, beyond –30% or +50%, from the original cost estimate are discussed. The cost breakdown is limited to that which was presented in the RSER or RSER/EE/CA.

9.0 REFERENCES

This section provides a list of the documents that are referred to in the RAR.

Figures and Tables

A sample of the figures and tables that may be included in the RAR are listed below. Figures and tables will be specific for the OU/facility. Tables may be presented in the body of the document or in appendices if appropriate.

Figure 1. Location on SRS Map

Table 1. Chronology of Events
Table 2. Summary of Design Changes
Table 3. Project Cost Comparison

Appendices

Appendices and attachments are included as appropriate. Appendices are sampling plans, Action Memorandum and Responsiveness Summaries, removal action field start notifications, notification of construction completions, as-builts, test results, etc.

Attachments are stand-alone documents with document numbers. Examples of attachments are engineering design drawings and plans and/or vendor-supplied drawings and plans.

This page is intentionally left blank.

FORMAT FOR RESPONSES TO REGULATORY COMMENTS

This document format provides instructions for preparing written responses to EPA and SCDHEC comments on regulatory reviewed documents. A separate set of responses is prepared for EPA and SCDHEC.

Comment Response Header

- Header will include the subject line from the EPA or SCDHEC comment submittal.
- For the submittal of the draft responses, add the words "DRAFT SRS Responses to" before the EPA or SCDHEC subject line.
- Following regulatory agreement on the responses, remove the "DRAFT" designation from the header.
- Include the date comments were officially received.
- Include page numbers (i.e., Page X of Y).

Comment Response Format

- Repeat the regulator comments verbatim as received.
- Following the comment, add a Response line followed by "Agree", "Disagree", or "Clarification". The SRS response should be in bold font.
- Provide a brief, factual, and technically supported explanation to support the response.
- If no change to the document is needed, state "No change to the document is proposed" in the response.
- If changes to the document are needed, identify the location in the text where the change will be made by section and paragraph. (Do not identify by page number as text will shift with revisions.) Include the revised text in the response as it will appear in the document, if practicable. Identify deleted text with strikethrough and new text with underline.
- Attach new or revised figures and tables with the comment responses.
- Identify the Responsible Party by name, phone number, and email address.

Refer to the format example for preparing responses to regulatory comments.

EXAMPLE

DRAFT SRS Responses to United States Environmental Protection Agency
Comments on the
Record of Decision, Remedial Alternative Selection for the Stormwater Outfall A-013 (NBN)
Operable Unit (U), SEMS Number: 62, SRNS-RP-2020-00904, Revision 0, January 2021
Savannah River Site, South Carolina

Comments Received: March 24, 2021
Page 1 of 1

SPECIFIC COMMENTS

1. Declaration for the Record of Decision, Assessment of the Site, Page *ii* of *iv*. Please add the following text to the *Assessment of the Site* paragraph: "There is no current or potential threat to public health, welfare, or the environment from the Stormwater Outfall A-013 OU."

Response: Agree. Text will be added to the Declaration for the Record of Decision, Assessment of the Site, as follows:

"As part of the selected remedy, the future land use for the Stormwater Outfall A-013 OU will be unrestricted. <u>There is no current or potential threat to public health, welfare, or the environment from the Stormwater Outfall A-013 OU.</u>"

Responsible Party: John Doe, (803) 952-9594, john.doe@srs.gov

2. Declaration for the Record of Decision, description of the Selected Remedy, Page *ii* of *iv*. Please add the following text to the Description of the Selected Remedy paragraph" "The Stormwater Outfall A-013 poses no unacceptable risk based on an unlimited exposure and unrestricted land use scenario."

Response: Agree. Text will be added to the Declaration for the Record of Decision, Description of the Selected Remedy, second paragraph, as follows:

"As part of the selected remedy, the future land use for the Stormwater Outfall A-013 OU will be unrestricted. <u>The Stormwater Outfall A-013 poses no unacceptable risk based on an unlimited exposure and unrestricted land use scenario.</u>"

Responsible Party: John Doe, (803) 952-9594, john.doe@srs.gov

FACILITY DECOMMISSIONING EVALUATION FORMAT

The Facility Decommissioning Evaluation (FDE) documents the rigorous and systematic review of all available information about a facility or group of facilities and is used to determine which decommissioning model (i.e., Simple Model, Integrated Sampling Model, or Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Model) is to be used for decommissioning.

Introduction

This section contains an evaluation of available existing information about a facility that is slated for decommissioning. This evaluation screens the project to determine whether it is appropriate to conduct the decommissioning under CERCLA or to use a simpler graded approach.

The FDE consists of three sections. Part 1 contains a description of the project scope including a brief summary of the purpose and history of the facility and photographs of the structures that are part of the project. Part 2 encompasses a series of questions, the answers to which determine the decommissioning model (CERCLA Model, Integrated Sampling Model, or Simple Model) that is proposed for use. The three graded approach models are described in Facility Disposition Manual 1C, Procedure 501. Part 2 also includes a justification for the answers to each question. Part 3 is a list of references that were used for the evaluation.

Conclusion

One of the following statements is included to describe the results of the evaluation.

> *"This project will be conducted using a CERCLA Model described in Facility Disposition Manual 1C, Procedure 501. A CERCLA Model is a CERCLA removal or remedial action and includes the documentation of alternative evaluations and the stakeholder involvement prescribed in 40CFR300.415."*

or

"This facility is (or may be) contaminated, and the facility hazard category is Other Industrial. This project will be conducted using the Integrated Sampling Model described in Facility Disposition Manual 1C, Procedure 501."

or

"A review of the existing characterization data, process/building history, sample data and walk downs of the facility, supports the determination that this building and its ancillary structures meet the criteria of a Clean Building, Simple Model as described in Facility Disposition Manual 1C, Procedure 501. This decision is supported by the information reported throughout the body of this document. No chemical or hazardous radioactive contaminants are associated with this structure."

Part 1. Project Scope

Scope

This section identifies the buildings and ancillary structures that are within the scope of the evaluation that was prepared in accordance with requirements found in Facility Disposition Manual 1C, Procedure 502, "Preparing Decommissioning Decision Documents."

If the end state is Demolition, the following standard language is included.

"The proposed decommissioning end-state for this facility is demolition to the building slab/foundation and removal of the debris.[1]"

For facilities using the CERCLA decommissioning model, the following standard language is included.

"The cleanup criteria and the method for achieving them will be determined by an alternatives analysis."

If the end state is In Situ Disposal and the facility is clean, the following standard language is

[1] It is generally sufficient to demolish a building to its slab/foundation. If it is necessary to achieve complete removal, then the statement is amended to accurately describe the proposed end state.

included.

> *"The proposed decommissioning end-state for this facility is In Situ Disposal. Demolition is impractical, and consequently a portion of the facility will remain intact after decommissioning."*

If the end state is In Situ Disposal and the facility is not clean, the following standard language is included.

> *"The proposed decommissioning end-state for this facility is In Situ Disposal. Demolition is impractical, and consequently a portion of the facility will remain intact after decommissioning. Cleanup criteria, the method for achieving them, the amount of residual contamination, and the method of sealing it in place will be determined by an alternatives analysis, using the CERCLA decommissioning model."*

The following standard language is included for all but simple model.

> *"Any contamination in the building slab/foundation will be removed to a level that satisfies the applicable risk-based end-state. Decommissioning will target the EPA acceptable risk range for an Industrial Worker scenario with no contaminant migration potential to groundwater. Residual contamination will be defined and justified in the subsequent Decommissioning Project Final Report (DPFR) for Integrated Sampling Models or appropriate regulatory-required documentation for CERCLA Models. Contaminants and/or releases to the environment, not associated with the facility being decommissioned, are not within the scope of the decommissioning project."*

The following standard language is included for all.

> *"The described decommissioning activities are not the final area closure actions. The decommissioning of a building is intended to reduce landlord costs, increase safety by removing excess facilities and reduce the potential for releases of hazardous substance to the environment."*

Facility Description

This section provides a brief description of the structure or structures that compose the facility to be decommissioned, where they are located, and what they were used for. Photographs are included as appropriate. When the facility was built and identification of ancillary structures as well as dimensions, construction materials, equipment remaining, etc., are presented.

Process History

This section describes the chemical or radioactive process that were performed in the building. A process is defined as when some chemical, mechanical, or electrical energy or interaction was performed to change the state of an input material or to produce a new output product; the mere storage of material is not a process. A description of the nature, amount, and extent of contaminated areas in the facility is provided. Floor plans, maps, or other diagrams wherever possible are included. In every case, the presence (or not) of floor drains is indicated. If floor drains are present, a description of whether they have been plugged and when that occurred is provided. Where the floor drains/sumps discharge to is identified (e.g., sanitary sewer, storm water, process waste, etc.). The integrity of the slab is described by indicating whether there are cracks that may penetrate the thickness of the slab and where they are located. In particular, this is described for areas where stains have been observed. Sumps, drains, secondary containments, stained concrete (evidence of spills), heavy equipment, process areas, chemical and waste storage areas, rad contaminated areas, and radiological areas are marked on the floor plan as appropriate. Tables that summarize chemical processes (i.e., chemical name, process location, evidence of spills) and radioactive processes (i.e., isotopes, contaminated areas/others) are included to provide a summary of what materials were processed or stored in the facility. Any facility remnants other than concrete pads (e.g., underground process lines, underground storage tanks) that the United States Department of Energy (USDOE) intends to leave in place for evaluation during the Area Closure Process are identified.

Summary of Existing Characterization

This section describes the characterization that has been accomplished using a combination of process knowledge/historical release information, verification walk downs and sampling as

appropriate.

The following standard language is included.

> *"An important part of the characterization portion of this evaluation is a historical review of spills/releases to the environment. This review includes a review of the Occurrence Reporting and Processing System/Site Item Reportability and Issue Management (ORPS/SIRIM) database conducted from the effective date of the Federal Facility Agreement (FFA), August 16, 1993 to present, and a review of the FFA. The FFA serves as a review of releases/spills to the environment prior to August 16, 1993."*

Historical Significance

This section provides the results of a review that has been conducted in accordance with a Programmatic Agreement and publication of a Cultural Resources Management Plan.

Part 2. Evaluation

This section encompasses a series of questions, the answer to which determine the decommissioning model (CERCLA Model, Integrated Sampling Model, Simple Model). The questions are presented in a tabular format and includes a justification for the answers to each question.

Clean Facilities

1. Has the facility ever contained or processed radioactive or hazardous material other than stored packaged material or materials of construction? *If Yes, go to question 4.*
2. If there was stored packaged material, has there ever been a spill? *If No or N/A, this is a Simple Model. Stop.*
3. Was spill confined inside structure and cleaned to free release standard per Radiological Control Manual 5Q (for radiological) or continued occupancy per Industrial Hygiene Manual 4Q (for hazardous)? *If Yes, this is a Simple Model. Stop.*

Contaminated Facilities

4. Is the facility listed as a Resources Conservation and Recovery Act (RCRA)/CERCLA Unit in Appendix C of the SRS FFA? *If Yes, this is a CERCLA Model. Stop.*
5. Is the facility listed as a Site Evaluation Area in Appendix G of the SRS FFA? *If Yes, this is a CERCLA Model. Stop.*
6. Is there evidence that there has been a release of hazardous or radioactive materials outside the structure? *If Yes, this is a CERCLA Model. Stop.*
7. Is there a substantial threat of a release of hazardous or radioactive materials outside the structure? *If Yes, this is a CERCLA Model. Stop.*
8. Has the facility been assigned a hazard category as defined in Facility Safety Document Manual 11Q? If No, stop and refer facility (except guard shacks, warehouses, office buildings, and other clean facilities with no chemical or radiological hazards) for evaluation to assign a hazard category, then proceed.
9. Is the hazard category Nuclear (HC- 2 or 3), radiological, or high hazard chemical? *If Yes, this is a CERCLA Model. Stop*.
10. Has USDOE-SR directed that the decommissioning be performed using the CERCLA Model? *If Yes, this is a CERCLA Model. Stop.*
11. Does the complexity of the facility or the nature and extent of contamination warrant a higher than normal level of rigor and detail for decommissioning planning and evaluation? *If Yes, this is a CERCLA Model. Stop.*
12. Is the facility a formerly nuclear, radiological, or high-hazard chemical facility? *If Yes, this is an Integrated Sampling Model. Stop.*
13. Have cognizant Engineering personnel and the Decommissioning Project Environmental Compliance Authority jointly concluded that a final survey is not required for this facilty? *If Yes, this is a Simple Model. Provide justification for changing the screening to Simple Model by giving the reason the change was made. If No, this is an Integrated Sampling Model. Stop.*

Part 3. Review of Existing Records

This section provides a list of the facility records that were reviewed as part of the evaluation.

Figures and Tables

A sample of the figures and tables that may be included in the FDE are listed below. Figures and tables will be specific for the facility.

Figure 1. Location of Facility
Figure 2. Photograph of Facility
Figure 3. Floor Plan/Map of Facility
Figure 4. Facility Process Flow Diagram

Table 1. Chemical Process
Table 2. Radioactive Process
Table 3. References

This page is intentionally left blank.

DECOMMISSIONING PROJECT FINAL REPORT FORMAT

The Decommissioning Project Final Report (DPFR) is a document prepared for facilities that are decommissioned using the Simple Model or Integrated Sampling Model, after the decommissioning activities have been performed and verified. The DPFR describes the decommissioning project activities and accomplishments, and final facility status/end state. For Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) models, Removal Action Reports (RARs) or the appropriate post-remedial action documents (i.e., Remediation Action Completion Reports [RACRs]) are completed in lieu of DPFRs.

1.0 SUMMARY

This section provides a summary of the contents of the report and must include the following:

- A brief description of the building: name, year of construction, location of building, what the building was used for, and, if applicable, how it came to be contaminated.
- The decommissioning model used (Simple Model or Integrated Sampling Model).
- The ultimate end state condition after decommissioning was completed. Text is included that clearly defines what, if any, remnants remain following the completion of decommissioning.
- The conclusion that the risk associated with residual contamination is acceptable based on a final verification survey. A statement is included if no final verification survey was required.
- The party/parties responsible for performing the decommissioning, (i.e., construction, subcontractor).

For a clean facility Simple Model decommissioning, the following information is included:

- Determination that this facility meets the criteria of a Clean Building, Simple Model as described in the Facility Disposition Manual 1C, Procedure 501.

- Decision supported by information reported in the Facility Decommissioning Evaluation (FDE).
- Statement that there was no evidence of contamination and no final verification survey was required.

For an Integrated Sampling Model facility, the following information is included:

- Conclusion of the Human Health Risk Assessment (HHRA) (Section 6.2.1)
- Conclusion of the Contaminant Migration (CM) Analysis (Section 6.2.2).

2.0 PURPOSE AND SCOPE

This section describes the purpose of the report: to document what was done to the facility as a part of the decommissioning project, and the condition the facility was left in at the completion of the project. The requirement for this report is reported in the Facility Disposition Manual 1C, Procedure 506, "Preparing a Decommissioning Project Final Report." Interactions with regulatory agencies, i.e., South Carolina Department of Health and Environmental Control (SCDHEC) and U.S. Environmental Protection Agency (USEPA), for concurrence on this report are governed by the "Core Team Protocol for Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports."

2.1 Facility Description

This section provides a brief description of the facility. If appropriate, the facility description from the applicable FDE may be used. A listing of any ancillary structures or a statement that there are no ancillary structures is included in this section. If appropriate, before and after photos of ancillary structures are provided in Appendix A.

2.2 New Facility Information

This section discusses any "new information" regarding the facility that was not disclosed or known at the time of FDE concurrence. The intent of this section is to update information reported in the FDE. This section may also include a statement if there is no new facility information to report.

3.0 DECOMMISSIONING MODEL APPROVAL

This section describes the decommissioning model approval as documented in the FDE. The description includes the groups involved in walkdowns of the facility and the dates of the regulator (i.e., SCDHEC and USEPA) walkdown of the facility and FDE concurrence. If a regulator walkdown did not occur, a statement that no facility walkdown occurred and a brief description why is included.

4.0 DECOMMISSIONING ACTIVITIES COMPLETED

This section lists and/or discusses the primary decommissioning activities that were completed as planned and described in either the Decommissioning Project Plan or the FDE, and the Decommissioning End Points Document. A description is provided of what activities were included in the scope of work and that the decommissioning was confirmed complete in a Final Acceptance Inspection. If not already addressed in Section 2.2, a description of what changes were made to the original plan, if any, is provided.

5.0 WASTE MANAGEMENT

5.1 Salvage and Reuse

This section identifies major equipment or classes of components that were removed from the facility and released for salvage or reuse. Any problems or difficulties encountered in performing that release and how the obstacles were resolved is discussed. Bulk quantities of salvaged material by weight or volume are summarized.

5.2 Waste Disposal

This section identifies classes and descriptions of material that were declared waste, removed from the facility, and disposed of. Quantities by volume or weight for each type of waste (RCRA hazardous, TSCA, low level, transuranic, mixed) is provided. All wastes generated during decommissioning are included and presented in the form of a table describing each waste classification, the waste source, accurate name of the disposal site, and total volume or weight.

The information should be explicit about the generation of hazardous or universal waste associated with the decommissioning project.

6.0 FINAL FACILITY CONDITION

6.1 Final Facility Condition and Remaining Hazards

This section states that decommissioning is complete and describes in detail how the facility was left at the end of decommissioning. A description of any structural or other features that remain, locations where the facility was isolated from its surroundings and connections, and final physical configuration are included. An explicit unambiguous statement about whether the slab/foundation remains or not is included. A summary of any remaining hazards or a statement that there are no remaining hazards is provided.

6.2 Risk Assessment Summary

This section summarizes the evaluation of residual risk based on the final verification survey, including independent verification, if required. The content and format of this section depends on the decommissioning model employed.

For a clean facility Simple Model decommissioning, the following paragraphs are sufficient for section 6.2.

> *"A review of the existing characterization data, process/building history, sample data and walkdowns of the facility prior to decommissioning supported the determination that this building [insert if applicable and its ancillary structures] met the criteria of a Clean Building, Simple Model as described in Manual 1C, Procedure 501.*
>
> *This decision was supported by the information reported in the FDE [insert reference]. No chemical or hazardous radioactive materials were associated with this structure other than commonly used materials of construction, which were managed as waste during demolition in accordance with established Savannah River Site (SRS) practices. The amounts of such materials were described in Section 5.2 of this report. Since there was no evidence of contamination on the slab before demolition or on the facility remnants after structure demolition, no final verification survey was required."*

For all other facilities, the following summary is included and modified as necessary to suit the conditions at the facility.

> *"A HHRA and an evaluation of the potential for contaminant migration to groundwater were conducted on the Building [insert facility #] slab based on a final verification survey that included biased sample locations. Potential risks/hazards based on a reasonable maximum exposure (RME) scenario were estimated for an industrial worker hypothetically exposed to residual contamination at [insert facility]. The radiological cancer risk based on a RME scenario for a future industrial worker exposed to the general slab areas is estimated to be [insert number]. For chemical contaminants, the cancer risk to a future industrial worker exposed to the general slab areas was estimated to be [insert number]. The RME non-cancer hazard index (HI) for the general slab areas was estimated to be [insert number]."*

The results of the contaminant migration analysis is also summarized in this section.

The following Sections 6.2.1, 6.2.2 and 6.2.3 are only included when the facility is decommissioned under the Integrated Sampling Model.

6.2.1 Data

This section describes the source of data, number/types of samples, and exposure groupings or areas. A reference to a sample location map and data summary table is provided. Appendices B and C are referenced, as appropriate.

6.2.2 Human Health Risk Assessment

This section describes the HHRA as outlined in the Environmental Compliance & Area Completion Projects (EC&ACP) Regulatory Document Handbook, Module 6 Human Health Risk Protocols. Appendix D is referenced, as appropriate. A description of the following topics is included in this section.

- Receptor Description
- Sources of Toxicity Values
- HHRA Process

- HHRA Results
- HHRA Uncertainty Evaluation
- HHRA Conclusion

6.2.3 Contaminant Migration Analysis

This section describes the CM analysis as outlined in the EC&ACP Regulatory Document Handbook, Module 5 Contaminant Migration Protocols. A reference to Appendix E is included, as appropriate. A description of the following topics is included in this section.

- Vadose Zone Contaminant Fate and Transport Model Description
- Contaminant Migration Analysis Results
- Contaminant Migration Uncertainty Evaluation
- Contaminant Migration Conclusion

6.3 Post Decommissioning Requirements

This section describes if the remaining structure is free of physical, chemical, and radiological hazards and whether further decommissioning action is required. For facilities with remaining fixed radioactive contamination, any monitoring/maintenance/surveillance activities that are identified while awaiting Area Completion are described. The SRS Environmental Compliance & Area Completion Program will address the remaining contamination during Area Completion activities.

7.0 CONCLUSIONS/RECOMMENDATIONS

This section summarizes the final result of the decommissioning project, including:

- The building has been demolished or sealed permanently (in situ disposal).
- What remains in place and in what physical condition.
- All wastes were disposed of in accordance with federal and state requirements.

- The remaining structure has no residual contamination or has a small amount of residual contamination that is well below the authorized limit.
- Describes any long term stewardship requirements at the remaining structure or states that there are none.

In most cases, the following text can be used and modified as needed.

"[Insert Building #] was demolished, and the foundation has been left in place. All decommissioning activities have been completed, including waste disposal in accordance with federal and state regulations. The remaining structure is free of physical, chemical, and radiological hazards; therefore, it needs no further decommissioning action. No surveillance and maintenance (S&M) activities were identified for the remaining structure, because it poses no threat to human health or the environment while awaiting area completion."

For Simple Model decommissioning, the following text is used.

"In accordance with the "Memorandum of Agreement for Achieving an Accelerated Cleanup Vision at the Savannah River Site," this report will be maintained as a record for reference and use in the [insert area] Completion, Record of Decision. To ensure facility remnants are addressed during the completion process, Building [insert Facility #] should be added to Appendix K.2 of the Federal Facility Agreement for the SRS. However, no further evaluation during the Area Completion process will be necessary."

For Integrated Sampling Model decommissioning, the following text is used.

"In accordance with the "Memorandum of Agreement for Achieving an Accelerated Cleanup Vision at the Savannah River Site," this report will be maintained as a record for reference and use in the [insert area] Completion, Record of Decision. To ensure facility remnants are addressed during the completion process, Building [insert Facility #] should be added to Appendix C.4 of the Federal Facility Agreement for the SRS."

8.0 REFERENCES

This section includes a list of the documents that are referred to in the DPFR. The following are included as a minimum.

- FDE
- Concurrence letter(s) for FDE
- Final Verification Survey Report (not required for clean facilities, Simple Model)
- Final Acceptance Inspection of Facility

9.0 APPENDICES

Appendix A – Before and After Photos of the Facility/Structure
Appendix B - Sample Location Map
Appendix C - Data Summary Table
Appendix D - Human Health Risk/Hazard Calculation
Appendix E - Contaminant Migration Analysis

Figures and Tables

A sample of the figures and tables that may be included in the DPFR are listed below. Figures and tables will be specific to the facility.

Figure 1. Facility Exposure Area(s) (If appropriate, based on the information in 6.2.1.)

Table 1. Waste Generation

Part II

Technical Protocols

This page is intentionally left blank.

PROTOCOL

Development of Exposure Groups

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. Before characterizing a unit, a conceptual site model should be developed. In this model, a concept of the potential human and ecological receptors, the type of contaminated media at the unit, and exposure pathways will be identified. Each is described briefly below.

Receptors

Human health and ecological receptors are the known and hypothetical humans and other biota which may come into contact with contaminated media at the unit.

Media

Media of potential concern are defined as any medium through which human or ecological receptors may be exposed to constituents or through which constituents may be transported to potential receptors. Typical media include the following:

- Surface soil
- Subsurface soil
- Sediment
- Surface water
- Groundwater (by aquifer)
- Air
- Biota
- Concrete slab/building materials

Exposure Routes

Transport routes of constituents to receptors include the following:

- Ingestion (of soil, water, etc.)
- Inhalation (of dust particles, vapors)
- Dermal exposure
- External radiation

The purpose of the development of exposure groups (EGs) is to provide an estimate of the concentration of contaminants for a particular media within a particular area in order to support a

data analysis of the extent of contamination at the unit and the risks associated with the presence of the contaminants.

The first step in the process is to determine the concentrations of contaminants in each of the media of potential concern. The data analysis process begins with two sets of samples, as follows:

- unit-source samples (potential contaminated areas)
- background samples (located outside the potential area of contamination)

Data from the investigation will be further grouped into sets and subsets for each medium. Exposure group, abbreviated as 'EG,' is the term used to refer to the appropriate set of data that will be used to calculate the exposure point concentration for a given medium of potential concern. Special EGs may be developed for hot spots, if needed.

The second step in the process is to determine if the contaminants have the potential to migrate from their present locations. Appropriate EGs are specified to support this analysis.

The third step in the process is to determine risks for each of these *receptor/media/route* combinations. These risks will be estimated in order to determine the media risk as presented in the protocols for contaminant migration analysis (Module 5), human health risk assessment (Module 6) and ecological risk assessment (Module 7). Appropriate exposure groups are specified to support this analysis.

Details

Background Exposure Groups

Background datasets represent similar habitats/media that are located outside the potentially contaminated areas. The background datasets are used to determine if unit-related concentrations are elevated above background. In essence, background data represents the range of values for naturally occurring constituents that can be compared to unit concentrations. For the soil medium, the *Background Soils Statistical Summary Report for the Savannah River Site*[1] (WSRC 2006) is a very robust dataset that has been approved for risk screening and provides statistical summaries for many naturally occurring constituents at SRS as shown below.

- Appendix B-1. Upland Soils (0 to 0.3 m [0 to 1 ft] interval)
- Appendix B-2. Upland Soils (all depth intervals)

There are typically three exposure groups for site-specific background soils.

- Soil from 0 to 0.3 m (0 to 1 ft), background for the unit.
- Soil from 0.3 to 1.2 m (1 to 4 ft), background for the unit.
- Soil from 0 to WT (water table), background for the unit.

[1]WSRC 2006. *Background Soils Statistical Summary Report for the Savannah River Site,* ERD0-EN-2005-0223, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

For sediments, all of the available data from background samples should be pooled, as appropriate.

For surface water, all of the available data from background samples should be pooled, as appropriate.

For groundwater, all of the available data from background samples should be pooled, as appropriate.

Contaminant Migration Exposure Group

The exposure group for contaminant migration includes all of the unit-source soil analytical results for all of the samples taken anywhere between the surface of the unit soils and the uppermost aquifer. All of these data will be pooled into one exposure group. Other EGs may be developed, as needed, such as those which represent hot spots.

Risk Assessment Exposure Groups

In the risk assessment, consideration will be given to a variety of *receptor/media/route* combinations. It is important to note that EGs are developed for each unit under investigation and are tailored to the needs of the risk assessment for that unit. Additional EGs may be developed, as needed.

Typical EGs are as follows:

- Soil from 0 to 0.3 m (0 to 1 ft), over the area of the unit.
- Soil from 0.3 to 1.2 m (1 to 4 ft), over the area of the unit.
- Soil from 0 m (0 ft) to WT (water table) over the area of the unit.
- Sediment from 0 to 0.3 m (0 to 1 ft) in nearby drainage areas.
- Surface Water in a nearby water body.
- Groundwater in a designated aquifer system (may be in the highly concentrated area of the plume, if appropriate).
- Exposed concrete slabs (or other building materials).

This page is intentionally left blank.

PROTOCOL

Exposure Pathways/Conceptual Site Model Development

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. The purpose of this protocol is to provide clarification on the concept of exposure pathways and the development of a conceptual site model (CSM).

The development of the CSM is an iterative process that begins during the sampling and analysis planning phase and is continually refined throughout the RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment (RFI/RI/BRA) process. Initially, the CSM provides a representation of the source of contamination and how it was released into the environment based on historical information. It also includes potential release mechanisms and exposure routes based on the existing understanding of the nature and extent of contamination. In addition, potential human and ecological receptors are identified in the CSM based on the location of the unit with respect to actual and/or potential hypothetical future access and surrounding habitats. Once the BRA is completed, the CSM is revised to illustrate the significant pathways and receptors that are potentially at risk.

Exposure pathways describe the course a chemical or physical agent takes from the source to the exposed receptor. The following seven components constitute an exposure pathway:

1. Primary Sources
2. Primary Sources Environmental Release Mechanisms
3. Secondary Sources
4. Secondary Sources Environmental Release Mechanisms
5. Exposure media (soil, sediment, surface water, concrete, etc.)
6. Exposure route (external radiation, ingestion, dermal contact, inhalation, etc.)
7. Receptor (resident, worker, wildlife, etc.)

If any of these elements is missing, the pathway is incomplete and is not considered further in the quantitative risk assessment. A pathway is complete when all seven components are present to permit potential exposure of a receptor to a source of contamination. Exposure analysis is important in terms of identifying all potentially complete exposure routes, understanding the nature and extent (as well as fate and transport) of contamination, and developing preliminary remedial alternatives. In a complete pathway, exposure occurs at exposure points that may represent only a small portion of the entire exposure route. If there is no exposure point, then there is no exposure, and the pathway is considered incomplete.

Figure 1 provides an example of a preliminary CSM that has been prepared prior to formal data evaluation in the RFI/RI/BRA for a typical operable unit (OU). Figure 2 is an example of a refined

CSM that has been prepared after the refined constituents of concern (RCOCs) have been identified.

Details

Primary Source

The primary source contains a brief description of the waste(s) initially disposed of within the OU. The primary source is usually known or assessed from review of historical documentation. Some examples include: liquid discharged into a basin, debris buried in a pit, solvents spilled on the ground, liquid effluents released from an outfall, etc. If an operable unit has more than one primary source, or the areas of disposal of the primary source are being investigated independently, then separate CSMs should be prepared for each.

Primary Release Mechanism

The primary release mechanism describes how contaminants from the primary source enter the environment or impact secondary sources. Some examples include deposition directly from the primary source as in the case of a liquid release to a basin, runoff, leakage from deteriorating drums, leakage from pipeline joints, etc.

Secondary Source

The secondary source includes the environmental media contaminated by the release of the primary source. Initially, the secondary source is assumed to include soil beneath and/or adjacent to the primary source material and surface water (if appropriate). For ease of representation, the secondary sources are typically divided into exposure groups (usually surface soil [0 to 0.3 m {0 to 1 ft}], subsurface soil [0.3 to 1.2 m {1 to 4 ft}], deep soil [>1.2 m {4 ft}, all depths], and surface water). If direct runoff from the primary source to a surface water body is not appropriate, then surface water should not be shown as a secondary source. Additionally, the method of transport between soil exposure groups is labeled (e.g., infiltration/percolation).

Secondary Release Mechanism

Secondary release mechanisms should include processes that currently, or may in the future, release contaminants for exposure to potential receptors. Secondary release mechanisms typically include fugitive dust generation, volatilization, biotic uptake, radiation emissions, leaching, and excavation (usually applied to all soil depths interval).

Exposure Media

All media that could potentially be contaminated should be listed beneath the exposure media category. The media should be listed separately for each different exposure group (i.e., surface soil and subsurface soil should be listed separately).

Exposure Route

The exposure route identifies the method of entry into the receptor (e.g., inhalation, ingestion, dermal contact, external radiation).

Potential Receptors

Human and ecological receptors are identified on the same CSM, as appropriate, in the data collection Work Plan and early stages of the RI processes. Following the completion of the BRA, the CSM is revised to summarize the potential risks/hazards for each receptor by exposure routes.

Human Health

For the human health portion of the CSM, potential future exposure scenarios are typically represented by an on-unit resident (child and adult) and an industrial worker. Depending on the location of the waste unit with respect to the SRS boundary and access control, site-specific workers, trespassers, or recreational users may also be considered as potential receptors.

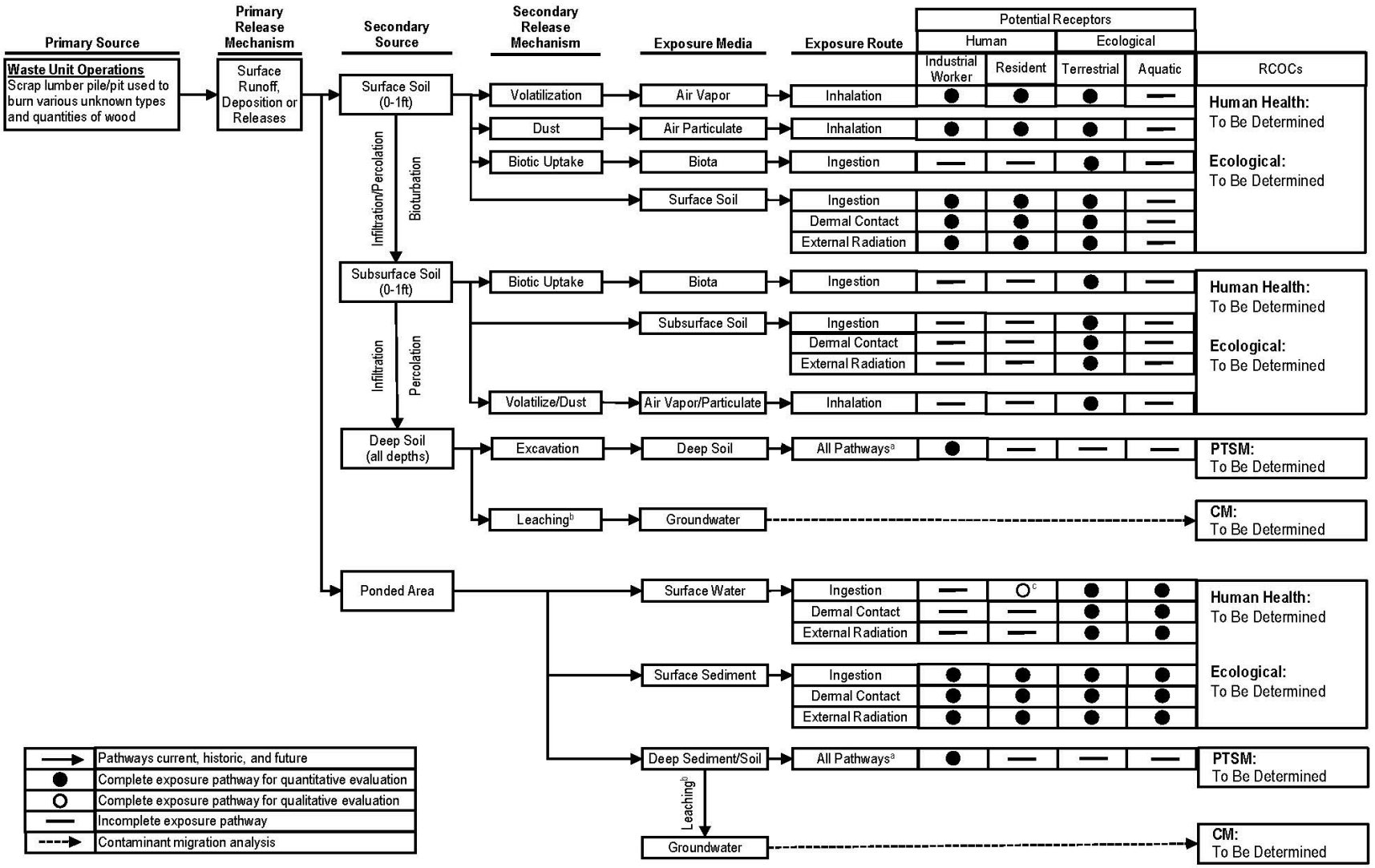
Ecological

Ecological receptors are defined as plant and animal populations and communities, habitats, and sensitive environments/threatened, endangered and sensitive species. Generic descriptions of potential ecological receptors (i.e., terrestrial or aquatic/semi-aquatic) are presented in the CSM. If deemed appropriate, a more detailed food-web diagram may be presented in the ecological risk assessment portion of the BRA.

Refined CSMs

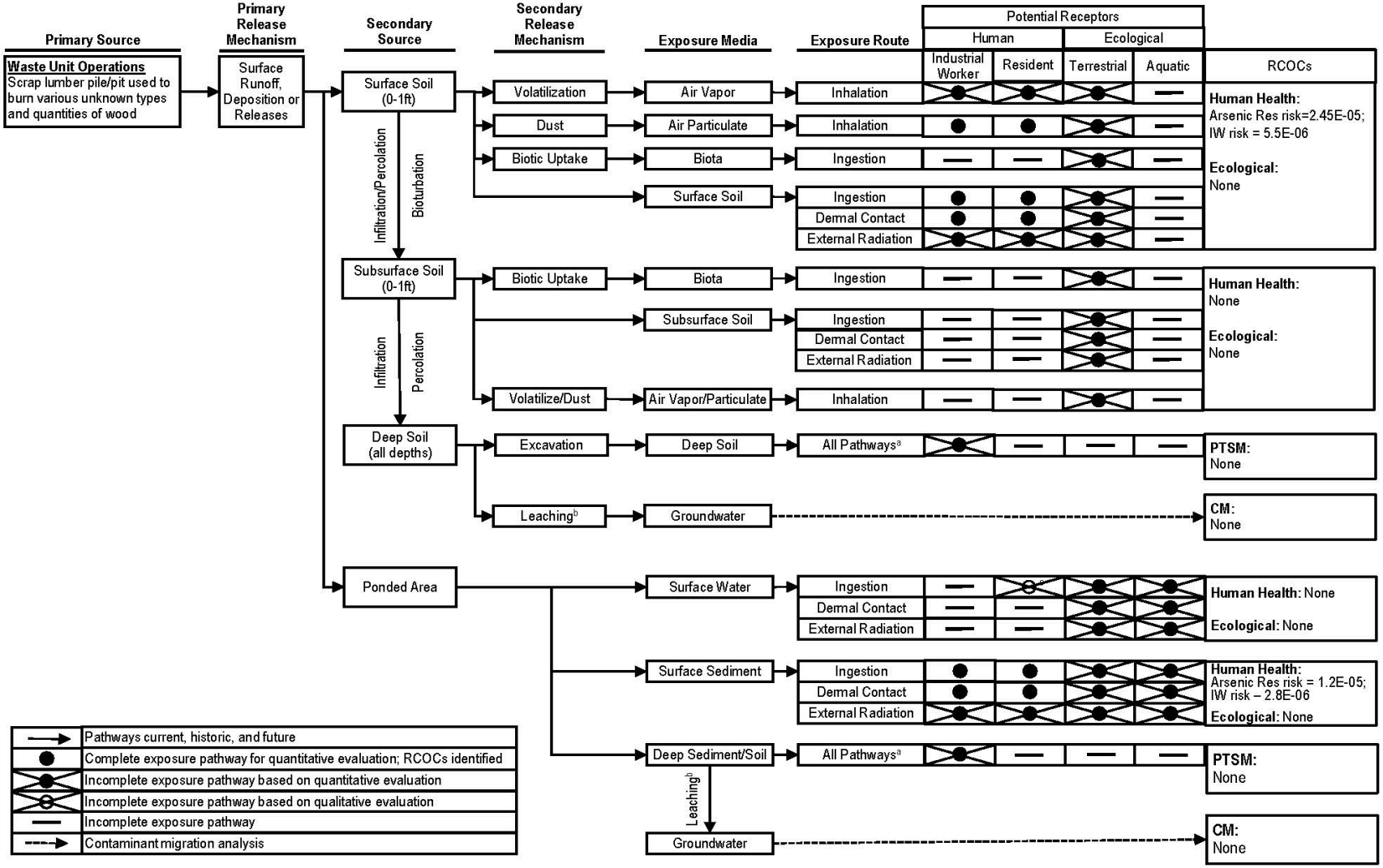
Refined CSMs provide a summary of the results of the risks/hazards calculated in the BRA. Results of the human health risk and ecological risk assessment, principal threat source material evaluation, and contaminant migration analysis are shown in a refined CSM to provide a visual summary of potential risk/hazards for each receptor by exposure route.

This page is intentionally left blank.



a – All Pathways represent ingestion, inhalation, dermal contact and external radiation exposure for the principal threat source material (PTSM) evaluation for toxicity.
b – Leaching represents the potential of a contaminant in soil or sediment to migrate to groundwater above MCLs per the contaminant migration (CM) analysis and does not represent a human or ecological exposure route.
c - Surface water evaluated by comparison to MCLs/AWQC.

Figure 1. Sample Preliminary Conceptual Site Model



a – All Pathways represent ingestion, inhalation, dermal contact and external radiation exposure for the principal threat source material (PTSM) evaluation for toxicity.
b – Leaching represents the potential of a contaminant in soil or sediment to migrate to groundwater above MCLs per the contaminant migration (CM) analysis and does not represent a human or ecological exposure route.
c - Surface water evaluated by comparison to MCLs/AWQC.

Figure 2. Sample Refined Conceptual Site Model

PROTOCOL

Addressing the Combined Surficial Risks from Adjacent Units

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. It provides guidance on the methodology for addressing the combined surficial risks from Subunits within an Exposure Unit in support of an Area Completion strategy. A Subunit is an individual Federal Facility Agreement (FFA) waste unit or a facility (remnant) remaining after decommissioning. An Exposure Unit is a grouping of Subunits based on the areal extent of a receptor's movements during a defined time period. The protocol instructions are based on the latest available USEPA guidance and agreement from the staff of USEPA, SCDHEC, and USDOE.

Exposure Unit Determination

Exposure Units should be determined by the Core Team during project scoping following a review of existing data and site-specific information. In the absence of an industry standard on the anticipated range for a future industrial worker, the Exposure Unit area designation is determined on a site-specific basis by the Core Team.

Based on an assumed range for a future industrial worker in an Area Operable Unit (OU) setting, the typical size of an Exposure Unit is 1 to 5 acres. However, exceptions may include larger, homogeneous waste sites, or smaller, geographically isolated waste sites as determined by the Core Team. When defining the Exposure Unit boundaries, the first designation should be based on a reasonable maximum exposure (RME) scenario (worst case) to minimize underestimating the risk over a larger area. Existing features such as roads, fences, or other natural breaks/features may also be considerations in defining the boundary. The Exposure Unit's unavailability to potential receptors needs to be taken into consideration when defining the physical dimensions of each Exposure Unit. If the pathways for exposure are incomplete due to greater restrictions (e.g., physical barriers and institutional controls), then that should be identified as such on the Conceptual Site Model and not be included in the Exposure Unit area designation. Ultimately, the Exposure Unit designation should be determined by the Core Team based upon project specific considerations.

Each Subunit must be accounted for in an Exposure Unit. A Subunit should not be divided between Exposure Units. A remedial decision will be made for each Exposure Unit and could address multiple Exposure Units in an Area Operable Unit (OU) setting.

Exposure Unit Risk Evaluation Methodology

Typically, human health risk in the environmental restoration program is evaluated on a Subunit-by-Subunit basis; this approach may also be appropriate in some cases for an Area OU evaluation (e.g., a release site or waste unit that is geographically isolated from the rest of the area). Additionally, a receptor-specific exposure area approach which combines the risk of individual Subunits within an Exposure Unit may be more efficient for data collection and remedial decisions.

In addition to the individual Subunit risk evaluation, the Exposure Unit risk is determined using an area-weighted approach. The area of each Subunit is weighted against the total Exposure Unit area to estimate the risk contribution of each subunit to the Exposure Unit. The Exposure Unit risk estimate is determined by considering the area-weighted Subunit risks.

Details

A risk assessment should be performed for each Subunit (waste units/facilities) within an Exposure Unit. Calculation of the risk estimate for each Subunit will be in accordance with EC&ACP protocols (*Human Health Constituent of Concern Protocol*, HH-5). Refined COCs (RCOCs) should be identified in accordance with the *Refinement of Constituents of Concern Protocol* (COC-1).

For each Subunit, the risk will be considered in the Exposure Unit risk evaluation if there are RCOCs identified.

The Exposure Unit risk is calculated by using an area-weighted approach. This approach considers the range of the receptor (i.e., industrial worker) and the amount of time that the worker would theoretically spend at each of the Subunits. The formula for calculating the Exposure Unit risk estimate is provided below:

Exposure Unit risk estimate = Sum of [(risk for Subunit) x (area of Subunit / area of the Exposure Unit)]

Example Calculation for Exposure Unit

Summary of Risk Estimate and Area of Each Subunit in Exposure Unit

Subunit	Risk Estimate	Area
FFA Waste Unit A	2.0E-05	2.5 acre
FFA Waste Unit B	Site Evaluation NFA	0.3 acre
FFA Waste Unit C	No RCOCs (i.e., <1E-06)	0.2 acre
D&D Building Slab D	8.0E-06	1.0 acre
D&D Building Slab E	Simple Model[1]	0.1 acre
Space not occupied by subunits		0.9 acre
	Total Area of Exposure Unit =	**5 acres**

1 The term "Simple Model" is part of the graded approach implemented by Site Deactivation & Decommissioning (D&D) that is based on the hazards commensurate with the unit's relative importance to safety and degree of complexity. Simple model facilities are assumed to have <1E-06 risk for a future industrial worker (i.e., negligible chemical or radiological risk) and will not be included in the Area Operable Unit or subsequent area evaluations (in accordance with FFA 1993, Section XL).

In this example, only 2 subunits area determined to contribute to the overall Exposure Unit risk.

Risk Estimate Using an Area-Weighted Approach

Subunit[1]	Risk Estimate[2]	Weighted Area[3]	Area-Weighted Risk Estimate[4]
FFA Waste Unit A	2.0E-05	2.5 acre/ 5 acre = 0.5	1.0E-05
D&D Building Slab D	8.0E-06	1 acre/ 5 acre = 0.2	1.6E-06
		Exposure Unit Risk[5] =	**1.2E-05**

1. Only those subunits with RCOCs identified are considered in the Exposure Unit risk estimate.
2. Risk estimate = result of risk evaluation using EC&ACP protocols.
3. Weighted area = area of the Subunit/area of the Exposure Unit
4. Area-weighted risk estimate = risk estimate x weighted area
5. Exposure Unit risk = sum of the weighted area risks of each of the Subunits

This page is intentionally left blank.

PROTOCOL

Unit-Source Data Processing

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. The protocol applies to the processing of data for use in the RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment (RFI/RI/BRA) report.

This data processing protocol will be applied to each unit-source exposure group (EG) as specified in the *Development of Exposure Groups Protocol* (DG-1). An exposure group, abbreviated as 'EG', is the term used to refer to the set of data that will be used to calculate the exposure point concentration for a given medium of potential concern.

Details

Determine Unit-Source Maximum Values

For each constituent in each exposure group for the unit-source samples, determine the maximum value from the detected concentrations only. Designate the value as the unit-source maximum value for the EG.

Calculate Unit-Source Average Values

For each constituent in each exposure group of unit-source samples, determine the average value of all samples. The *USEPA ProUCL for Environmental Applications for Data Sets With and Without Nondetect Observations* software package should be used to calculate the mean value. ProUCL uses the Kaplan-Meier (KM) method to estimate the mean value for datasets with nondetects. If ProUCL is not able to process the data due to a low frequency of detects or limited number of samples, then calculate the mean using surrogate values for the non-detect results. The *Surrogates for Non-Detects Protocol* (DP-3) provides further information on the methodology for determining surrogate values for non-detect results.

Reasonable Maximum Exposure (RME) Values

1. Determine the UCL 95 value[1]. The *USEPA ProUCL for Environmental Applications for Data Sets With and Without Nondetect Observations* software package should be used to

[1] "Supplemental Guidance to RAGS: Calculating the Concentration Term," EPA Publication 9285.7-081, May 1992. The UCL 95 value is at the 95 percent upper confidence level of the population mean.

calculate the UCL 95 value. The ProUCL software recommends the most appropriate UCL based on the best fit of the data.

2. For each constituent in each exposure group for the unit-source samples, compare the UCL 95 value and the maximum value. Designate the lower of these two as the unit-source reasonable maximum exposure (RME) concentration for that constituent in that EG.

PROTOCOL

Unit-Background Data Processing

Introduction

This protocol has been developed to support the Savannah River Site (SRS) environmental remediation program. This protocol applies to the processing of unit-background data for use in the RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment (RFI/RI/BRA) report.

This data processing protocol will be applied to each background exposure group as specified in the *Development of Exposure Groups Protocol* (DG-1). An exposure group, abbreviated as 'EG', is the term used to refer to the set of data that will be used to calculate the exposure point concentration for a given media of potential concern.

The *Background Soils Statistical Summary Report for the Savannah River Site*[1] (WSRC 2006) is a very robust dataset that has been approved by the Core Team for risk screening and provides statistical summaries for many naturally-occurring constituents at SRS. This protocol applies to determining unit-specific background concentrations (e.g., anthropogenic constituents) from unit-specific samples if needed for the Operable Unit.

Details

Determine Unit-Background Maximum Values

For each constituent from the unit-background samples, determine the maximum value from the detected concentrations only. Designate the value as the unit-background maximum value.

Calculate Unit-Background Average Values

For each constituent from the unit-background samples, determine the arithmetic average value of all samples using surrogate values for the non-detect results. The *Surrogates for Non-Detects Protocol* (DP-3) provides further information on the methodology for determining surrogate values for non-detect results.

[1]WSRC 2006. *Background Soils Statistical Summary Report for the Savannah River Site,* ERD-EN-2005-0223, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC

This page is intentionally left blank.

PROTOCOL

Surrogates for Non-Detects

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. The protocol applies to the processing of data for use in the RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment (RFI/RI/BRA) report. Method Detection Limits (MDLs) for nonradioactive constituents and Method Detection Activities (MDAs) for radionuclides are used as surrogates for non-detects.

The *USEPA ProUCL for Environmental Applications for Data Sets With and Without Nondetect Observations* software package should be used to calculate the UCL 95 value[1]. Non-detected constituent concentrations should be processed in accordance with the ProUCL User's Guide for the UCL 95 calculation and the mean calculation. If ProUCL is not able to process the data due to a low frequency of detects or limited number of samples, then calculate the mean using surrogate values for the non-detect results as shown below.

Details

Method for Determining Surrogate Values for Sample Results Reported as Non-Detect

- Use a surrogate value equal to one-half (1/2) of the sample-specific method detection limit (ssMDL) for nonradioactive constituents.
- Use a surrogate value equal to one-half (1/2) of the sample-specific method detection activity (ssMDA) for radionuclides.

[1] "Supplemental Guidance to RAGS: Calculating the Concentration Term," EPA Publication 9285.7-081, May 1992. The UCL 95 value is at the 95 percent upper confidence level of the population mean.

This page is intentionally left blank.

PROTOCOL

Unit-Specific Constituents

Introduction

The following protocol has been developed to support the Savannah River Site (SRS) environmental remediation program. This protocol addresses the identification of unit-specific constituents (USCs). The exposure groups to be used in this process have been described in the *Development of Exposure Groups Protocol* (DG-1). This process is intended to be used after application of the *Unit-Source Data Processing Protocol* (DP-1).

Details[1]

1. For each constituent in each unit-source exposure group[2], compare the unit-source maximum concentration to twice (2x) the SRS background soil average concentration from the *Background Soils Statistical Summary Report for the Savannah River Site*[3] (WSRC 2006) or twice (2X) the calculated unit-specific background average value (protocol DP-2). In a table, identify the unit-source maximum concentration as either greater than twice the average background concentration or less than the twice the average background concentration. Those constituents whose unit-source maximum concentrations are greater than twice the average background concentrations are labeled as USCs.
2. Based on professional judgment, prepare planar maps, cross-sectional plots, or other illustrations for USCs in each exposure group which will be useful in illustrating the nature and extent of contamination at the operable unit. The nature and extent of contamination summary and conclusions will provide the method of managing uncertainty where interpretation is not possible based on inadequate data quality or quantity.

[1] Note that the USC screening is used for nature and extent discussion and for contaminant migration analysis. It is not used as the basis for risk analysis.

[2] For the soils medium, use only the 0 to water table (all-depths) exposure groups for the unit-source and the SRS background (or unit-specific background).

[3] WSRC 2006. *Background Soils Statistical Summary Report for the Savannah River Site,* ERD-EN-2005-0223, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC, Appendix B-2.

This page is intentionally left blank.

PROTOCOL

ARAR Constituents of Concern

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. It provides instructions for the evaluation of unit-source data for contaminant concentrations which may exceed concentration-based applicable or relevant and appropriate requirements (ARARs). These constituents will be identified as ARAR constituents of concern (ARAR COCs).

Details

1. Identify all chemical-specific ARARs for the unit. Typically this list will include maximum contaminant levels (MCLs) for groundwater, ambient water quality standards (AWQS), and/or MCLs for surface waters, and the soil limits for polychlorinated biphenyls (PCBs) and lead. PCBs are governed by the Toxic Substances Control Act (TSCA) (40 CFR Part 761). TSCA action levels are based on site-specific conditions. The unrestricted land use (high occupancy) threshold for PCBs is 1 milligram per kilogram (mg/kg). For lead in soil, the value of 400 mg/kg was set by the U.S. Environmental Protection Agency Office of Solid Waste Emergency Response and adopted as a to-be-considered (TBC) for the screening process.

2. For each exposure group, compare the unit-source constituent maximum value to the ARAR value. If the unit-source maximum constituent concentration is greater than the ARAR value, identify the constituent as an ARAR COC for that exposure group. Drop the constituent from further consideration as an ARAR COC if it is less than the screening value.

3. The constituents identified as ARAR COCs will be carried forward in the RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment (RFI/RI/BRA) report for uncertainty analysis (*Constituents of Concern Refinement Process Protocol* [COC-1]), and in the development of *ARAR Preliminary Remedial Goals Protocol* (ARAR-2), if appropriate.

This page is intentionally left blank.

PROTOCOL

ARAR Preliminary Remedial Goals

Introduction

This protocol has been developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of applicable or relevant and appropriate requirements (ARARs) preliminary remedial goals (PRGs). This protocol is intended to be used after assessing the data per the *ARAR Constituents of Concern Protocol* (ARAR-1).

Details

1. For the constituents identified as ARAR constituents of concern (COCs), perform an uncertainty analysis per the *Constituents of Concern Refinement Process Protocol* (COC-1) in order to evaluate such factors as the conceptual site model (CSM), probable conditions, frequency of detection, site history, and data quality for each constituent. Per the uncertainty analysis, consider whether the amount of uncertainty in the analysis is too large to warrant retention of the ARAR COC. If the ARAR COC is not to be retained, provide a detailed discussion in the uncertainty section of the RCRA Facility Investigation/ Remedial Investigation/ Baseline Risk Assessment (RFI/RI/BRA). Those COCs which are retained are identified as ARAR refined constituents of concern (RCOCs).
2. The appropriate ARAR PRGs will be developed for ARAR RCOCs remaining after the uncertainty analysis.
3. ARAR PRGs are established at the maximum contaminant level (MCL) concentration for groundwater, at the ambient water quality standard (AWQS) and/or MCL for surface waters, and at the soil limits for polychlorinated biphenyls (PCBs) and lead. PCBs are governed by the Toxic Substances Control Act (TSCA) (40 CFR Part 761). The TSCA action levels are based on site-specific conditions. The unrestricted land use (high occupancy) threshold for PCBs is 1 milligram per kilogram (mg/kg). For lead in soil, the value of 400 mg/kg was set by the U.S. Environmental Protection Agency Office of Solid Waste Emergency Response and adopted as a to-be-considered (TBC) for the screening process.

This page is intentionally left blank.

PROTOCOL

Contaminant Migration
Vadose Zone Contaminant Migration Multi-Layered Model

Introduction

This protocol has been developed to support the Savannah River Site (SRS) environmental remediation program. The purpose of this protocol is to provide guidance and ensure consistency on using the Vadose Zone Contaminant Migration Multi-Layered (VZCOMML©)[1] modeling program for initial contaminant migration (CM) assessments of SRS operable units (OUs).

The VZCOMML© modeling program is a spreadsheet model that performs a series of calculations that simulate one-dimensional, steady-state, vadose zone contaminant fate and transport to provide a conservative estimate of the impact to groundwater posed by the OU source contamination. The modeling program is designed to: 1) perform a detailed OU-specific vadose zone contaminant fate and transport analysis; 2) perform vadose zone CM analysis that complies with the protocols agreed to by the United States Environmental Protection Agency (USEPA), South Carolina Department of Health and Environmental Control, and United States Department of Energy; 3) calculate and evaluate source (vadose zone) Preliminary Remedial Goals; 4) evaluate and compare the effectiveness of remedial action alternatives; and 5) allow the user to modify infiltration rates and geochemical parameters. The modeling program is consistent with *USEPA Soil Screening Guidance* (USEPA 540/R-96/018).

The modeling program will calculate all necessary vadose zone CM parameters including the dilution attenuation factor, mixing zone, pore-water velocity, retardation, maximum travel time constituent to groundwater, groundwater concentration, and soil screening levels (SSLs). The SSL is the minimum soil concentration of a constituent that may lead to a groundwater exceedance above a threshold value in the underlying aquifer. The appropriate SSL (i.e., OU-specific or mass-limited) for each constituent based on the conceptual site model must be determined. The VZCOMML© modeling program can be applied to all chemicals and metals on the USEPA Target Analyte List and Target Compound List and a radionuclide suite of approximately 200 constituents in total. Constituents are flagged if they fail the following screens: 1) soil concentrations greater than the appropriate SSL; and 2) groundwater concentrations greater than the screening level (USEPA Maximum Contaminant Level [MCL] or in the absence of a MCL, USEPA Regional Screening Level for tap-water set at a 1E-06 risk level for carcinogens and/or hazard quotient equal to 1 is used) with a mean travel time less than 1,000 years.

[1] Vadose Zone Contaminant Migration Multi-Layered Model, Version 4.0, Copyright TXu 1-663-361, 2009, Savannah River Nuclear Solutions, LLC.

The VZCOMML© modeling program provides an initial conservative CM screen of the OU-specific constituents. The modeling program may greatly reduce (or eliminate) the number of constituents that need to be carried forward for uncertainty analysis and/or detailed modeling. Constituents that fail the VZCOMML© modeling program screens should be evaluated using more detailed vadose zone modeling programs such as, but not limited to, SESOIL, MEPAS, RESRAD, VLEACH, or GoldSim. More detailed vadose zone modeling programs are able to consider parameters which reduce the conservatism that is provided by VZCOMML© modeling program.

Details

There are four modules in the VZCOMML© modeling program that require user input based on OU-specific data and desired model parameters: 1) Dilution Factor Module, 2) Pore-Water Velocity Module, 3) Geotechnical Data Module, and 4) Soil Concentration Module.

The VZCOMML© modeling program is self-contained and will print the input parameters entered into the program and the outputs calculated by the modeling program. The modeling program also contains a list of equations that documents how the calculations are performed. Typical model parameters input by the user and the standard units are provided in the table below.

Table 1. User Input Parameters for VZCOMML©

Parameter	Definition	Unit
L	Source length parallel to groundwater flow	Feet
I	Vertical infiltration rate through vadose zone	Feet/Year
K_a	Aquifer saturated horizontal hydraulic conductivity	Feet/Year
d_a	Aquifer thickness	Feet
i	Horizontal hydraulic gradient in aquifer	Feet/Feet
T_{hi}	Thickness of layer “i ”	Feet
n_{ei}	Effective porosity of layer “i ”	Fraction
n_{Ti}	Total porosity of layer “i ”	Fraction
K_{si}	Saturated hydraulic conductivity of layer “i ”	Feet/Year
ED	Exposure duration	Year
T_e	Evaluation time	Year
ρ_b	Bulk density	Kilograms/Liter
f_{oc}	Fraction organic carbon in source layer	Fraction (decimal)

Screening results from the VZCOMML© modeling program calculations are presented to support the CM screening steps described in Protocol CM-2 *Contaminant Migration Constituents of Concern.*

PROTOCOL

Contaminant Migration Constituents of Concern

Introduction

This protocol has been developed to support the Savannah River Site (SRS) environmental remediation program. The analysis of contaminant migration (CM) through vadose zone soil to groundwater is typically executed using the Vadose Zone Contaminant Migration Multi-Layered (VZCOMML©) modeling program, as described in Protocol CM-1. The VZCOMML© modeling program provides the predicted maximum groundwater concentration and mean travel time for all evaluated constituents specific to the operable unit (OU). The purpose of this protocol is to describe the process to identify CM constituents of concern (COCs).

Typically, constituents identified as Unit-Specific Constituents (USCs) (protocol USC-1) are evaluated in the CM analysis. However, if USC screening was not performed, the CM analysis is initiated using the entire list of detected constituents from the United States Environmental Protection Agency (USEPA) Target Analyte List, USEPA Target Compound List, and a radionuclide suite.

The initial step in determining CM COCs is to identify the CM constituents of potential concern (CM COPCs). CM COPCs are constituents with the potential to migrate from vadose zone soils into groundwater under the most conservative assumptions. CM COPCs are determined by the Tier I analysis using the VZCOMML© modeling program, which uses the most conservative assumptions for all constituents within the OU, such as maximum detected concentrations and maximum depth of all samples taken.

Following the Tier I screen, the VZCOMML© modeling program inputs are refined to reduce conservatism and focus on the identified CM COPCs. This second screen is the Tier II screen, and constituents that continue to fail are considered the CM COCs. If no constituents are carried through as CM COPCs and/or CM COCs, then the CM analysis is complete.

This protocol is applied to all constituents, including radionuclides, except for the following constituents: calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium. These constituents are excluded because they are essential nutrients that are not considered to be toxic and do not have health based limits.

Considerations of contaminant migration are limited to a time frame of 1000 years. As explained in Nuclear Regulatory Commission guidance documents and existing regulations, there is a very

large uncertainty associated with predicting conditions beyond this time frame.[1,2,3,4] As needed, additional information from the United States Environmental Protection Agency (USEPA) Soil Screening Guidance[5] is referred to in this protocol.

Details

1. Consistent with Protocol CM-1, use the most conservative input parameters with the VZCOMML© modeling program to perform the Tier I screen and determine the CM COPCs for the OU.
2. Taking the reduced list of constituents (CM COPCs), use refined parameters specific to the individual CM COPCs in the VZCOMML© modeling program to perform the Tier II screen. Examples of refined parameters include, but are not limited to, average detected soil concentration for the OU, maximum detected depth of the specific constituent, soil partition coefficient based on the soil type. Based on the results of the Tier II screen, determine the CM COCs for the OU.
3. Constituents identified as CM COCs are carried forward to an uncertainty analysis (i.e., *Constituents of Concern Refinement Process Protocol* [COC-1]). If no CM COCs have been identified at this point, then the analysis is considered complete.
4. CM COCs retained after the uncertainty analysis may be further evaluated through supplemental modeling using a more robust modeling program such as, but not limited to, SESOIL, MEPAS, RESRAD, VLEACH, or GoldSim. The use of supplemental modeling should be justified based on OU-specific considerations, such as size of the source zone, combinative effects due to overlapping subunits, more applicable point of assessment, establishing multiple discrete vertical horizons in the vadose zone, etc. Further justification will be provided for CM COCs that are dismissed based on supplemental modeling.

1 NUREG 1500, Working Draft, “Regulatory Guide on Release Criteria for Decommissioning: NRC Staff’s Draft for Comment”, August 1994.
2 DG-8017, “Radiological Criteria for Decommissioning: Dose Calculations and Surveys”, Draft, September 21, 1995.
3 10 CFR 20. 1997. “Radiological Criteria for License Termination”. Code of Federal Regulations.
4 40 CFR 192. 1983. “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings”. Code Of Federal Regulations.
5 “EPA Soil Screening Guidance, Technical Background Document”, EPA/540/R-95/128, May 1996.

PROTOCOL

Contaminant Migration Preliminary Remedial Goals

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of contaminant migration preliminary remedial goals (CM PRGs) to establish potential cleanup levels for remedial decision making. This protocol applies to the contaminant migration refined constituents of concern (CM RCOCs) that are identified after performing an uncertainty analysis per the *Constituents of Concern Refinement Process Protocol* (COC-1).

Details

In order to back-calculate the CM PRGs, perform the next two steps in order, as appropriate.

1. For constituents with Maximum Contaminant Levels (MCLs), back calculate CM PRGs by determining the soil concentration needed in order to prevent exceedance of the groundwater MCL. Calculations are performed by Vadose Zone Contaminant Migration Multi-Layered modeling program[1]. This concentration becomes the CM PRG. If there is not a MCL, go to the next step.
2. Back calculate CM PRG by determining the soil concentration needed in order to prevent exceedance of the tapwater USEPA regional screening level (RSL).[2] Calculate the CM PRG concentration at the 1E-06 risk level for carcinogens and at the hazard quotient (HQ) equal to 1 for noncarcinogens. This concentration becomes the CM PRG.

[1] Vadose Zone Contaminant Migration Multi-Layered Model, Version 4.0, Copyright TXu 1-663-361, 2009, Savannah River Nuclear Solutions, LLC.

[2] USEPA RSLs for tapwater media are idenified in the *Sources of Human Health Screening Values Protocol, HH-1,* and are useful tools for identifying potential cleanup goals.

This page is intentionally left blank.

PROTOCOL

Sources of Human Health Screening Values

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It identifies sources of the screening values used in the human health risk assessment program for the various media of concern. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

Details

The purpose of this protocol is to identify the USEPA websites that are the sources of the various screening values used in the human health risk evaluation process as described in the following protocols; *Human Health Receptors and Scenarios* (HH-2), *Human Health RME Exposure Parameters* (HH-3), *Human Health Constituents of Potential Concern* (HH-4), *Human Health Constituents of Concern* (HH-5), *Human Health Preliminary Remedial Goals* (HH-6), and *Evaluation of Principal Threat Source Material (PTSM) at SRS Waste Units* (HH-7). USEPA provides multiple database tools with which to derive risk-based screening values using standard default parameters and the latest toxicity values; these websites also allow the user to modify input parameters to create site-specific values. The following websites are the primary sources of the human health screening values for the various environmental media.

Radiological Constituents

- *USEPA Preliminary Remediation Goals for Radionuclides (PRGs)*[1]

  PRGs are radionuclide screening values for soil, sediment, surface water, groundwater, air, fish, and biota media. The website publishes generic tables for soil and tap water media as well as a calculator function. For screening purposes, soil PRGs may be used to screen sediment media and tap water PRGs may be used to screen groundwater and surface water media. The website also publishes maximum contaminant levels (MCLs) for the evaluation of groundwater and surface water media.

  http://epa-prgs.ornl.gov/radionuclides/

- *USEPA Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRGs)*[2]

  SPRGs are radionuclide screening values for outdoor concrete surfaces.

  http://epa-sprg.ornl.gov/

- *USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs)*[3]

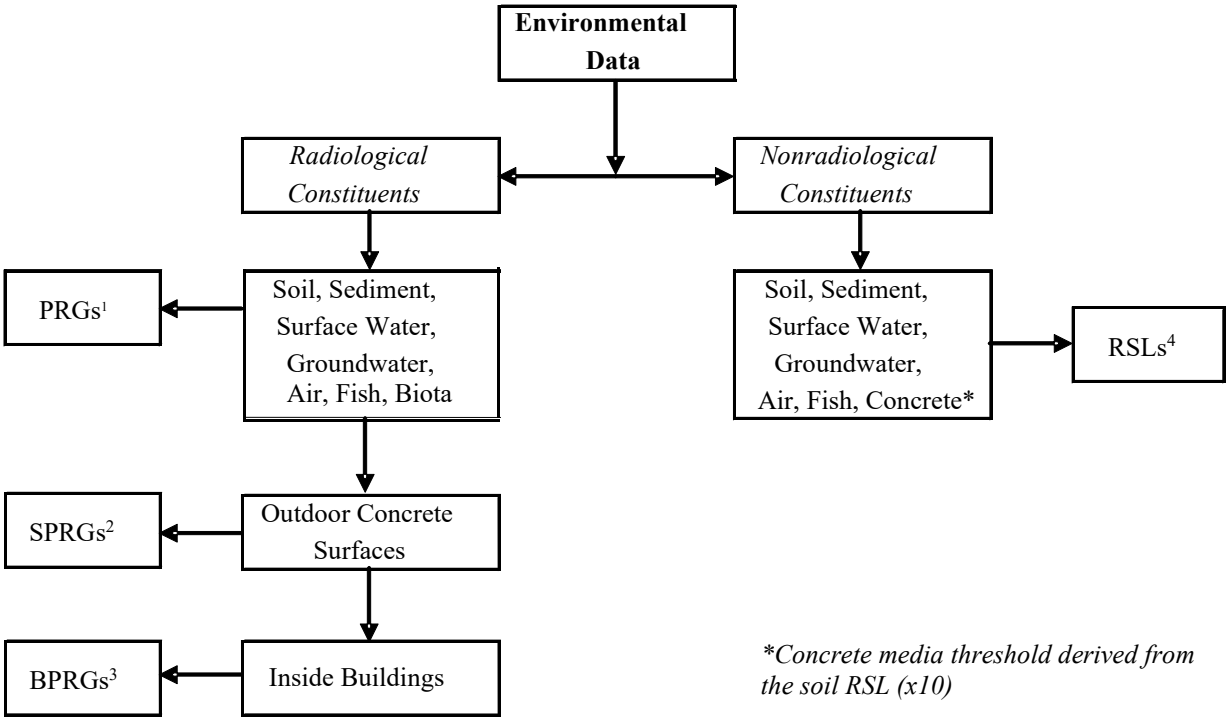
  BPRGs are radionuclide screening values for the interior of buildings.
  http://epa-bprg.ornl.gov/

Nonradiological Constituents

- *USEPA Regional Screening Levels (RSLs)*[4]

  RSLs are nonradionuclide screening values for soil, sediment, surface water, groundwater, air, and fish media. The website publishes generic tables for soil and tap water media as well as a calculator function. For screening purposes, soil RSLs may be used to screen sediment media and tap water RSLs may be used to screen groundwater and surface water media. The website also publishes MCLs for the evaluation of groundwater and surface water media. RSLs for concrete media are derived by multiplying the RSLs for soil media by ten (10x).
  http://epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm

The diagram below identifies the screening source for each constituent type (i.e., radiological or nonradiological) and environmental media of concern.



PROTOCOL

Human Health Receptors and Scenarios

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides details on the standard receptors and exposure scenarios used for human health risk evaluation. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

The receptor scenarios defined in this protocol are consistent with the standard scenarios described by USEPA. Details of the scenarios/exposure assumptions, etc., can be found at the USEPA websites that are described in the *Sources of Human Health Screening Values Protocol* (HH-1).

- *USEPA Preliminary Remediation Goals for Radionuclides (PRGs)* is the website tool used to obtain soil and tap water PRGs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRGs*) is the website tool used to obtain SPRGs for outdoor concrete slabs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs)* is the website tool used to obtain BPRGs for the interior of buildings for radionuclides.
- *USEPA Regional Screening Levels (RSLs)* is the website tool used to obtain soil and tap water RSLs for nonradionuclides.

A quantitative evaluation will be performed for the following on-unit hypothetical exposure scenarios:

(1) Future Resident

(2) Future Industrial Worker

This protocol provides brief descriptions of the standard human health receptor scenarios. Specific values for exposure parameters can be found in the *Human Health RME Exposure Parameters Protocol* (HH-3).

Details

Future Resident Exposure Scenario

The hypothetical future resident exposure scenario evaluates long term risks to individuals expected to have unrestricted use of the unit. It assumes that residents live on the unit and are exposed chronically, both indoors and outdoors, to unit contaminants. The future resident scenario includes adults and children who will be exposed to the contaminated media. The primary exposure routes for evaluation relative to the hypothetical on-unit resident (adult and child) include:

- Exposure to contaminated surface (0 to 0.3 m [0 to 1 ft]) soils or sediments (for nonradionuclides - incidental ingestion, dermal contact, inhalation of windblown dust or volatile constituents; for radionuclides - incidental ingestion, inhalation of windblown dust or volatile constituents, external exposure).
- Exposure to surface water or groundwater (for nonradionuclides – ingestion, inhalation of volatile contaminants [i.e., vapors generated by domestic water use], dermal contact; for radionuclides – ingestion, inhalation [i.e., vapors generated by domestic water use], immersion).

Typically, there is no need to calculate concrete PRGs for radiological constituents or RSLs for nonradiological constituents for the residential scenario. It is acknowledged that the areas for Area Completion will maintain some level of Land Use Controls to restrict residential land use. However, if the Core Team determines that the residential scenario is warranted, it can be evaluated using the default assumptions described in the appropriate USEPA website. In addition, waste units that may not be part of an Area Completion project typically require a residential evaluation if unrestricted land use (i.e., no Land Use Controls) is practicable.

Future Industrial Worker Exposure Scenario

The future industrial worker exposure scenario is a standard USEPA scenario which addresses long-term risks to workers who are chronically exposed to unit contaminants while working within an industrial setting. The future industrial worker is an adult who hypothetically works on-unit in an industrial setting for the majority of his time. The primary exposure routes for evaluation relative to the future industrial worker include:

- Exposure to contaminated surface (0 to 0.3 m [0 to 1 ft]) soils or sediments (for nonradionuclides - incidental ingestion, dermal contact, inhalation of windblown dust or volatile constituents; for radionuclides - incidental ingestion, inhalation of windblown dust or volatile constituents, external exposure).
- Exposure to contaminated concrete via incidental ingestion and dermal contact for nonradionuclides; external exposure for radionuclides.

The future industrial worker is identified as a composite worker[1] in the PRG, SPRG and RSL websites, and as an indoor worker in the BPRG website.

Other Site-Specific Human Health Receptor Examples

Evaluation of other human receptors such as onsite workers, trespassers, or recreational users may be appropriate in addition to the standard receptors presented above. Evaluation of additional receptors will be assessed on a case-by-case basis and approved by the project Core Team. Examples include the following:

- *Onsite Worker:* The onsite worker receptor scenario is site-specific and describes a worker who is performing maintenance, collecting site samples, or conducting research. The site-specific exposure assumptions may be based on input provided by the Savannah River Ecology Laboratory and describe a typical wetlands researcher.
- *Adolescent Trespasser:* The trespasser scenario is site-specific and describes a person who frequents the area for recreational (e.g., swimming/wading) and fishing purposes.
- *Recreational Fisher:* The recreational fisher receptor scenario is site-specific and describes a person who fishes infrequently. Recreational fishing is likely to involve direct contact with surface water, sediment, and soil. This exposure scenario is evaluated by comparing fish tissue concentrations to receptor-based threshold levels for fish based on ingestion of fillets.

[1] The composite worker scenario combines the most protective exposure assumptions of the outdoor and indoor worker scenarios The more protective exposure frequency of 250 days/year from the indoor worker scenario is used for the composite worker.

This page is intentionally left blank

PROTOCOL

Human Health RME Exposure Parameters

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It describes the exposure assumptions and input parameters used to derive the preliminary remediation goals (PRGs) and the regional screening levels (RSLs) that represent reasonable maximum exposure (RME) conditions. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

USEPA provides various database tools with which to derive risk-based PRGs/RSLs using standard default parameters and the latest toxicity values; these websites also allow the user to modify input parameters to create site specific PRGs/RSLs. Details of the scenarios/exposure assumptions, etc., can be found at the USEPA websites that are described in the *Sources of Human Health Screening Values Protocol* (HH-1).

- *USEPA Preliminary Remediation Goals for Radionuclides (PRGs)* is the website tool used to obtain soil and tap water PRGs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRGs*) is the website tool used to obtain SPRGs for outdoor concrete slabs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs)* is the website tool used to obtain BPRGs for the interior of buildings for radionuclides.
- *USEPA Regional Screening Levels (RSLs)* is the website tool used to obtain soil and tap water RSLs for nonradionuclides.

Specific conditions at a given unit may justify the use of differing assumptions. These unit-specific assumptions must be justified and approved by the project Core Team on a case-by-case basis. This protocol only identifies the assumptions for the standard exposure parameters that are described in the *Human Health Receptors and Scenarios Protocol* (HH-2). Site-specific assumptions may be used to generate more realistic risk scenarios for use in the weight of evidence discussion to determine refined constituents of concern (RCOCs).

Details

Non-radiological Constituents

The standard default parameters and input assumptions are used in the derivation of nonradiological RSLs for the future resident and future industrial worker scenarios unless otherwise noted. Details of the exposure assumptions are provided in the tables identified below and the USEPA RSL website. The specific RSL table (i.e., target hazard quotient [HQ] = 0.1 or 1) to be used in the data screening process is identified in the Human Health Constituents of Potential Concern Protocol (HH-4) and Human Health Constituents of Concern Protocol (HH-5), as appropriate.

- Future Resident
  - Soil media (Table 1): RSLs obtained from generic table at USEPA RSL website
  - Groundwater (tap water) (Table 2): RSLs obtained from generic table at USEPA RSL website
  - Surface Water*
  - Sediment*
- Future Industrial Worker
  - Soil media (Table 3): RSLs obtained from generic table at USEPA RSL website
  - Concrete media**: RSLs derived by multiplying RSLs for soil media from generic table at USEPA RSL website by ten (i.e., 10x soil RSL)

Radiological Constituents

The standard default parameters and input assumptions are used in the derivation of radiological PRGs for the future resident and future industrial worker scenarios, unless otherwise noted. Details of the exposure assumptions are provided in the tables and websites identified below. *NOTE: IF generic tables referenced below for the USEPA PRG, SPRG and BPRG websites are not available, use the website calculator to derive these values assuming default exposure assumptions unless otherwise noted.*

- Future Resident
  - Soil media (Table 4): eliminate fruit and vegetable pathways, assume all other default parameters, and use website calculator to derive site-specific PRGs at USEPA PRG website.
  - Groundwater (tap water) (Table 5): eliminate fruit and vegetable pathways, assume all other default parameters, and use website calculator to derive site-specific PRGs at USEPA PRG website.
  - Surface Water*
  - Sediment*

- Future Industrial Worker
  - Soil media (Table 6); PRGs for an outdoor worker obtained from generic table at USEPA PRG website (or calculator if generic table is unavailable).
  - Concrete media** outside surfaces (Table 7): Surfaces PRGs (SPRGs) for an Outdoor Worker, 2-D Direct External Exposure to Fixed Contamination Finite Slabs scenario, infinite depth of contamination option, from generic table (or calculator if generic table is unavailable) at USEPA SPRG website.
  - Concrete media** inside building (Table 8): Building PRGs (BPRGs) for an Indoor Worker, 3-D Direct External Exposure to Contaminated Building Materials scenario, modify room position to average (default is corner), infinite depth of contamination option and use website calculator to derive site-specific BPRGs at USEPA BPRG website.

*There are no standard default factors for surface water or sediment media. Exposure assumptions for the residential exposure to surface water or sediment media would be based on a project-specific recreational use scenario as approved by the project Core Team.

**It is recognized that the exposure assumptions for concrete media should not be the same as the exposure assumptions for soil media; however, no exposure information for concrete is available in technical literature or guidance. Because of the physical nature of concrete, it is expected that the ingestion, inhalation, and dermal contact pathways would be much less for concrete as compared to soil. The potential for exposure via these pathways for competent, hardened concrete is considered negligible. However, weathering of concrete could change the physical properties of the medium enough to allow some exposure through the ingestion pathway and potentially provide a media for which exposure could occur. For this reason, 1/10th of the standard exposure of non-radiological constituents in soil is a reasonable assumption for the available fraction of concrete due to weathering. This is considered a conservative approach since the ingestion, inhalation, and dermal contact pathways are all taken into consideration in the soil RSL calculation. A value of ten times (10x) the soil RSL shall be used in the risk estimate of non-radiological constituents for concrete media.

Other Site-Specific Human Health Receptor Examples

- *Onsite Worker: 20 years, 150 days/year, 8 hours/day*
- *Adolescent Trespasser: 10 years, 90 days/year, 18 hours/day (soil/sediment), 2 hours/day (surface water)*
- *Recreational Fisher: 26 years, 20 days/year, 6 hours/day, fish ingestion = 54 g/day*

This page is intentionally left blank.

Table 1. Exposure Assumptions for Resident Nonradiological Soil RSLs

Symbol	Definition (units)	Default	Reference[1]
Toxicity Values			
RfD_o	Chronic Oral Reference Dose (mg/kg-day)	Contaminant-specific	U.S. EPA Superfund hierarchy
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific	U.S. EPA Superfund hierarchy
CSF_o	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Contaminant-specific	U.S. EPA Superfund hierarchy
IUR	Inhalation Unit Risk $(ug/m^3)^{-1}$	Contaminant-specific	U.S. EPA Superfund hierarchy
Miscellaneous Variables			
THQ	Target Hazard Quotient	1	U.S. EPA 1990 (pg. 8718-8719)
TR	Target Risk	1E-06	U.S. EPA 1990 (pg. 8718-8719)
RBA	Relative Bioavailability Factor	Arsenic = 0.6 All Others = 1	U.S. EPA 2012
LT	Lifetime (years)	70	U.S. EPA 1989 (pg. 6-22)
$BW_{res\text{-}c}$	Resident Body Weight – child (kg)	15	U.S. EPA 1991a
$BW_{res\text{-}a}$	Resident Body Weight – adult (kg)	80	U.S. EPA 2011, Table 8-3
Ingestion and Dermal Contact Rates			
$IRS_{res\text{-}c}$	Resident Soil Ingestion Rate - child (mg/day)	200	U.S. EPA 1991a (pg. 15)
$IRS_{res\text{-}a}$	Resident Soil Ingestion Rate - adult (mg/day)	100	U.S. EPA 1991a (pg. 15)
$SA_{res\text{-}c}$	Resident Surface Area Soil - child (cm^2/day)	2373	U.S. EPA 2011 Tables 7-2 and 7-8
$SA_{res\text{-}a}$	Resident Surface Area Soil - adult (cm^2/day)	6032	U.S. EPA 2011 Tables 7-2 and 7-12
$AF_{res\text{-}c}$	Resident Soil Adherence Factor - child (mg/cm^2)	0.2	U.S. EPA 2002 (Exhibit 1-2)
$AF_{res\text{-}a}$	Resident Soil Adherence Factor - adult (mg/cm^2)	0.07	U.S. EPA 2002 (Exhibit 1-2)
ABS_d	Fraction of contaminant absorbed dermally from soil (unitless)	Contaminant-specific	U.S. EPA 2004 (Exhibit 3-4)
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless)	Contaminant-specific	U.S. EPA 2004 (Exhibit 4-1)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{res}	Resident Exposure Frequency (days/year)	350	U.S. EPA 1991a (pg. 15)
ED_{res}	Resident Exposure Duration (years)	26	U.S. EPA 2011, Table 16-108
$ED_{res\text{-}c}$	Resident Exposure Duration - child (years)	6	U.S. EPA 1991a (pg. 15)
$ED_{res\text{-}a}$	Resident Exposure Duration - adult (years)	20	ED_{res} (26 yrs) – $ED_{res\text{-}c}$ (6 years)
ET_{res}	Resident Exposure Time (hours/day)	24	24 hrs per 24 hr day
Particulate Emission Factor and Volatilization Factor Variables			
PEF	Particulate Emission Factor - Minneapolis (m^3/kg)	1.36E+09	U.S. EPA 2002 (Exhibit D-2)
VF_{ulm}	Volatilization Factor (soil) - Los Angeles (m^3/kg)	Contaminant-specific	U.S. EPA 2002, Equation 4-8

1 See USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites website for reference/citation details. http://epa.gov/reg3hwmd/risk/human/rb concentration_table/index.htm

Table 2. Exposure Assumptions for Resident Nonradiological Tap Water RSLs

Symbol	Definition (units)	Default	Reference[1]
Toxicity Values			
RfD_o	Chronic Oral Reference Dose (mg/kg-day)	Contaminant-specific	U.S. EPA Superfund hierarchy
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific	U.S. EPA Superfund hierarchy
CSF_o	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Contaminant-specific	U.S. EPA Superfund hierarchy
IUR	Inhalation Unit Risk $(ug/m^3)^{-1}$	Contaminant-specific	U.S. EPA Superfund hierarchy
Miscellaneous Variables			
THQ	Target Hazard Quotient	1	U.S. EPA 1990 (pg. 8718-8719)
TR	Target Risk	1E-06	U.S. EPA 1990 (pg. 8718-8719)
LT	Lifetime (years)	70	U.S. EPA 1989 (pg. 6-22)
$BW_{res\text{-}c}$	Resident Body Weight – child (kg)	15	U.S. EPA 1991a
$BW_{res\text{-}a}$	Resident Body Weight – adult (kg)	80	U.S. EPA 2011, Table 8-3
Ingestion and Dermal Contact Rates			
$IRW_{res\text{-}c}$	Resident Drinking Water Ingestion Rate – child (L/day)	0.78	U.S. EPA 2011, Table 3-33
$IRW_{res\text{-}a}$	Resident Drinking Water Ingestion Rate - adult (L/day)	2.5	U.S. EPA 2011, Table 3-33
$SA_{res\text{-}c}$	Resident Surface Area Water - child (cm^2)	6365	U.S. EPA 2014
$SA_{res\text{-}a}$	Resident Surface Area Water - adult (cm^2)	19652	U.S. EPA 2014
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless)	Contaminant-specific	U.S. EPA 2004 (Exhibit 4-1)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{res}	Resident Exposure Frequency (days/year)	350	U.S. EPA 1991a (pg. 15)
ED_{res}	Resident Exposure Duration (years)	26	U.S. EPA 2011, Table 16-108
$ED_{res\text{-}c}$	Resident Exposure Duration – child (years)	6	U.S. EPA 1991a (pg. 15)
$ED_{res\text{-}a}$	Resident Exposure Duration – adult (years)	20	ED_{res} (26 yrs) – $ED_{res\text{-}c}$ (6 years)
ET_r	Resident Exposure Time – resident (hours/day)	24	24 hrs per 24 hr day
$ET_{event\text{-}res\text{-}c}$	Resident Water Exposure Time – child (hours/event)	0.54	U.S. EPA 2011, Table 16-28
$ET_{event\text{-}res\text{-}s}$	Resident Water Exposure Time – adult (hours/event)	0.71	U.S. EPA 2011, Table 16-30 and 16-31
Volatilization Factor Variables			
K	Adelman Volatilization Factor (L/m^3)	0.5	U.S. EPA 1991b (pg. 20)

1 See USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites website for reference/citation details. http://epa.gov/reg3hwmd/risk/human/rb concentration_table/index.htm

Table 3. Exposure Assumptions for Industrial Worker Nonradiological Soil RSLs

Symbol	Definition (units)	Default	Reference[1]
Toxicity Values			
RfD_o	Chronic Oral Reference Dose (mg/kg-day)	Contaminant-specific	U.S. EPA Superfund hierarchy
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Contaminant-specific	U.S. EPA Superfund hierarchy
CSF_o	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Contaminant-specific	U.S. EPA Superfund hierarchy
IUR	Inhalation Unit Risk $(ug/m^3)^{-1}$	Contaminant-specific	U.S. EPA Superfund hierarchy
Miscellaneous Variables			
THQ	Target Hazard Quotient	1	U.S. EPA 1990 (pg. 8718-8719)
TR	Target Risk	1E-06	U.S. EPA 1990 (pg. 8718-8719)
RBA	Relative Bioavailability Factor	Arsenic = 0.6 All Others = 1	U.S. EPA 2012
LT	Lifetime (years)	70	U.S. EPA 1989 (pg. 6-22)
BW_w	Composite Worker Body Weight (kg)	80	U.S. EPA 2011, Table 8-3
Ingestion and Dermal Contact Rates			
IR_w	Composite Worker Soil Ingestion Rate (mg/day)	100	U.S. EPA 1991a (pg. 15)
SA_w	Composite Worker Soil Surface Area - adult (cm^2/day)	3527	U.S. EPA 2011, Table 7-2
AF_w	Composite Worker Soil Adherence Factor (mg/cm^2)	0.12	U.S. EPA 2011, Table 7-20
ABS_d	Fraction of contaminant absorbed dermally from soil (unitless)	Contaminant-specific	U.S. EPA 2004 (Exhibit 3-4)
GIABS	Fraction of contaminant absorbed in gastrointestinal tract (unitless)	Contaminant-specific	U.S. EPA 2004 (Exhibit 4-1)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_w	Composite Worker Exposure Frequency - (days/year)	250	U.S. EPA 1991a (pg. 15)
ED_w	Composite Worker Exposure Duration - (years)	25	U.S. EPA 1991a (pg. 15)
ET_w	Composite Worker Exposure Time (hours/day)	8	8 hrs per 24 hr day
Particulate Emission Factor and Volatilization Factor Variables			
PEF	Particulate Emission Factor - Minneapolis (m^3/kg)	1.36E+09	U.S. EPA 2002 (Exhibit D-2)
VF_{ulim}	Volatilization Factor soil - Los Angeles (m^3/kg)	Contaminant-specific	U.S. EPA 2002, Equation 4-8

1 See USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites website for reference/citation details. http://epa.gov/reg3hwmd/risk/human/rb concentration_table/index.htm

Table 4. Exposure Assumptions for Resident Soil Radiological PRGs

Symbol	Definition (units)	Default	Reference[1]
Slope Factors			
SF_s	Soil Ingestion Slope Factor – population (risk/pCi)	Isotope-Specific	ORNL-2014c
SF_i	Slope Factor - inhalation (risk/pCi)	Isotope-Specific	ORNL-2014c
$SF_{ext\text{-}sv}$	Slope Factor - external exposure – soil volume (risk/yr per pCi/g)	Isotope-Specific	ORNL-2014c
Dose and Decay Constant Variables			
TR	Target Risk	1E-06	U.S. EPA 1991b
t_{res}	Time - resident (years)	26	U.S. EPA 2011, Table 16-108
λ	Decay Constant = 0.693/half-life ($year^{-1}$) where 0.693 = ln(2)	Isotope-Specific	Developed for USEPA's "Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites" (NCRP 1996)
Miscellaneous Variables			
$ACF_{ext\text{-}sv}$	Area Correction Factor – soil volume (unitless)	Isotope-specific	ORNL 2014a
GSF_i	Gamma Shielding Factor – indoor (unitless)	0.4	U.S. EPA 2000a (pg. 2-22) U.S. EPA 2000b (pg. 2-18)
$GSF_{o\text{-}ext\text{-}sv}$	Gamma Shielding Factor – soil volume (unitless)	Isotope specific	ORNL 2014a
Inhalation, Ingestion, and Consumption Rates			
$IRS_{res\text{-}c}$	Resident Soil Ingestion Rate – child resident (mg/day)	200	U.S. EPA 1991a (pg. 15)
$IRS_{res\text{-}a}$	Resident Soil Ingestion Rate – adult resident (mg/day)	100	U.S. EPA 1991a (pg. 15)
$IRA_{res\text{-}c}$	Resident Inhalation Rate – child (m^3/day)	10	U.S. EPA 1997 (pg. 5-11)
$IRA_{res\text{-}a}$	Resident Inhalation Rate – adult (m^3/day)	20	U.S. EPA 1991a (pg. 15)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{res}	Resident Exposure Frequency – (days/year)	350	U.S. EPA 1991a (pg. 15)
ED_{res}	Resident Exposure Duration - (years)	26	U.S. EPA 2011a, Table 16-108
$ED_{res\text{-}c}$	Resident Exposure Duration – child (years)	6	U.S. EPA 1991a (pg. 6 and 15)
$ED_{res\text{-}a}$	Resident Exposure Duration - resident (years)	20	ED_{res} (26 yrs) – $ED_{res\text{-}c}$ (6 yrs)
ET_{res}	Resident Exposure Time (hours/day)	24	24 hours per 24 hour day
$ET_{res\text{-}i}$	Resident Exposure Time - indoor (hours/day)	16.416	U.S. EPA 2011 (Table 16-16)
$ET_{res\text{-}o}$	Resident Exposure Time - outdoor (hours/day)	1.752	U.S. EPA 2011 (Table 16-16)
Particulate Emission Factor Variables			
PEF	Particulate Emission Factor – Minneapolis (m^3/kg)	1.36E+09	U.S. EPA 2002 (Exhibit D-2)

1 See USEPA Preliminary Remediation Goals (PRGs) for Radionuclide Contaminants at Superfund Sites website for reference/ citation details. http://epa-prgs.ornl.gov/radionuclides/

Table 5. Exposure Assumptions for Resident Tap Water Radiological PRGs

Symbol	Definition (units)	Default	Reference[1]
Slope Factors			
SF_w	Water Ingestion Slope Factor (risk/pCi)	Isotope-Specific	ORNL 2014c
SF_i	Slope Factor - inhalation (risk/pCi)	Isotope-Specific	ORNL 2014c
SF_{imm}	Slope Factor – immersion (risk/yr per pCi/L)	Isotope-Specific	ORNL 2014c
Dose and Decay Constant Variables			
TR	Target Risk	1E-06	U.S. EPA 1991b
Inhalation, Ingestion, and Consumption Rates			
IRA_{res-c}	Resident Inhalation Rate – child (m^3/day)	10	U.S. EPA 1991a (pg. 15)
IRA_{res-a}	Resident Inhalation Rate - adult (m^3/day)	20	U.S. EPA 1991a (pg. 15)
IRW_{res-c}	Resident Tapwater Ingestion - child (L/day)	0.78	U.S. EPA 2011a, Tables 3-15 and 3-33
IRW_{res-a}	Resident Tapwater Ingestion - adult (L/day)	2.5	U.S. EPA 2011a, Tables 3-15 and 3-33
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{res}	Resident Exposure Frequency (days/year)	350	U.S. EPA 1991a (pg. 15)
ED_{res}	Resident Exposure Duration - resident (years)	26	U.S. EPA 2011a, Table 16-108
ED_{res-c}	Resident Exposure Duration- child (years)	6	U.S. EPA 1991a, pgs. 6 and 15
ED_{res-a}	Resident Exposure Duration - adult (years)	20	ED_{res} (26 years) – ED_{res-c} (6 years)
ET_{res}	Resident Exposure Time (hours/day)	24	24 hours per 24 hour day
$ET_{event-res-c}$	Resident Exposure Time per bathing event - child (hours/event)	0.54	U.S. EPA 2011, Table 16-30
$ET_{event-res-a}$	Resident Exposure Time per bathing event - adult (hours/event)	0.71	U.S. EPA 2011, Table 16-30
EV_{res}	Number of bathing events day (events/day)	1	
Volatilization Factor Variables			
K	Adelman Volatilization Factor (L/m^3)	0.5	U.S. EPA 1991b (pg. 20)

1 See USEPA Preliminary Remediation Goals (PRGs) for Radionuclide Contaminants at Superfund Sites website for reference/ citation details. http://epa-prgs.ornl.gov/radionuclides/

Table 6. Exposure Assumptions for Industrial Worker Soil Radiological PRGs

Symbol	Definition (units)	Default	Reference[1]
Slope Factors			
SF_{sa}	Soil Ingestion Slope Factor – adult only (risk/pCi)	Isotope-Specific	ORNL-2014c
SF_i	Slope Factor - inhalation (risk/pCi)	Isotope-Specific	ORNL-2014c
$SF_{ext\text{-}sv}$	Slope Factor - external exposure, soil volume (risk/yr per pCi/g)	Isotope-Specific	ORNL-2014c
Dose and Decay Constant Variables			
TR	Target Risk	1E-06	U.S. EPA 1991b
t_w	Time - worker (years)	25	U.S. EPA 1991a (pg. 15)
λ	Decay Constant = 0.693/half-life year^{-1}) where 0.693 = ln(2)	Isotope-Specific	Developed for USEPA's "Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites" (NCRP 1996)
Miscellaneous Variables			
$ACF_{ext\text{-}sv}$	Area Correction Factor – soil volume (unitless)	Isotope-Specific	ORNL 2014a
$GSF_{o\text{-}ext\text{-}sv}$	Gamma Shielding Factor – soil volume (unitless)	Isotope-Specific	ORNL 2014a
Inhalation, Ingestion, and Consumption Rates			
IRA_w	Composite Worker Inhalation Rate - (m^3/day; based on a rate of 2.5m^3/hr for 24hr)	60	U.S. EPA 1997a (pg. 5-11)
IRS_w	Composite Worker Soil Ingestion Rate – (mg/day)	100	U.S. EPA 1991a (pg. 15)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_w	Composite Worker Exposure Frequency - (days/yr)	250	U.S. EPA 1991a (pg. 15)
ED_w	Composite Worker Exposure Duration - (years)	25	U.S. EPA 1991a (pg. 15)
ET_w	Composite Worker Exposure Time (hours)	8	8 hrs per 24 hr day
Particulate Emission Factor Variables			
PEF	Particulate Emission Factor – Minneapolis (m^3/kg)	1.36E+09	U.S. EPA 2002 (Exhibit D-2)

1 See USEPA Preliminary Remediation Goals (PRGs) for Radionuclide Contaminants at Superfund Sites website for reference/citation details. http://epa-prgs.ornl.gov/radionuclides/

Table 7. Exposure Assumptions for Industrial Worker Outdoor Surfaces SPRGs

Symbol	Definition (units)	Default	Reference[1]
Slope Factors			
$SF_{ext\text{-}sv}$	External Exposure Slope Factor - direct (risk/yr per pCi/g)	Isotope-Specific	ORNL 2014c
Dose and Decay Constant Variables			
TR	Target Risk	1E-06	U.S. EPA 1990 (pg. 8718-8719)
t_w	Time – composite worker (years)	25	U.S. EPA 1991 (pg. 15)
λ	Decay Constant = 0.693/half-life ($year^{-1}$) where 0.693 = ln(2)	Isotope-Specific	Developed for USEPA's "Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites" (NCRP 1996)
Miscellaneous Variables			
$ACF_{ext\text{-}sv}$	Area Correction Factor – soil volume (unitless)	Isotope Specific	ORNL 2014a
GSF_s	Gamma Shielding Factor – Outdoor Surfaces (unitless)	1 (assumes no shielding)	U.S. EPA 2000a (pg. 2-22) U.S. EPA 2000b (pg. 2-18)
F_{AM}	Area and Material Factor (unitless)	1.0	ANL 2001 (Fig 8.6)
$F_{OFF\text{-}SET}$	Off-set Factor (unitless)	1.0	ANL 2001 (Fig 8.6)
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_w	Composite Worker Exposure Frequency (days/year)	250	U.S. EPA 1991 (pg. 15)
ED_w	Composite Worker Exposure Duration (years)	25	U.S. EPA 1991 (pg. 15)
ET_w	Composite Worker Exposure Time (hours/day)	8	U.S. EPA 2003 (pg. D-4)

1 See USEPA Preliminary Remediation Goals for Radionuclides on Outdoor Surfaces (SPRGs) at Superfund Sites website for reference/citation details. http://epa-sprg.ornl.gov/

Table 8. Exposure Assumptions for Industrial Worker Inside Building BPRGs

Symbol	Definition (units)	Default	Reference[1]
Slope Factors			
$SF_{ext\text{-}sv}$	External Exposure Slope Factor - direct (risk/yr per pCi/g)	Isotope Specific	ORNL 2014c
Dose and Decay Constant Variables			
TR	Target Risk	1E-06	U.S. EPA 1990 (pg. 8718-8719)
T_{iw}	Time – indoor worker (years)	25	U.S. EPA 2014 (Attachment 1)
λ	Decay Constant = 0.693/half-life ($year^{-1}$) where 0.693 = ln(2)	Isotope Specific	Developed for USEPA's "Preliminary Remediation Goals for Radionuclide Contaminants at Superfund Sites" (NCRP 1996)
Miscellaneous Variables			
GSF_b	Gamma Shielding Factor for building surfaces (unitless)	1 (assumes no shielding)	U.S. EPA 2000a (pg. 2-22) U.S. EPA 2000b (pg. 2-18)
F_{in}	Fraction time spent indoor (unitless)	1.0	ANL 2001 (Fig 8.1)
F_i	Fraction of time spent in compartment (unitless)	1.0	ANL 2001 (Fig 8.1)
F_{AM}	Area and Material Factor (unitless)	1.0	ANL 2001 (Fig 8.6)
$F_{OFF\text{-}SET}$	Off-set Factor (unitless)	1.0	ANL 2001 (Fig 8.6)
$F_{r\text{-}surfsv}$	Room Surfaces Factor for Infinite Soil Volume (unitless)	Isotope -Specific	Finklea 2015
--	Room Size (ft) – Room Position	10 x 10 x 10 - Average	Calculator options
Exposure Frequency, Exposure Duration, and Exposure Time Variables			
EF_{iw}	Exposure Frequency – indoor worker (days/year)	250	U.S. EPA 2014 (Attachment 1)
ED_{iw}	Exposure Duration – indoor worker (years)	25	U.S. EPA 2014 (Attachment 1)
ET_{iw}	Exposure Time – indoor worker (hours/day)	8	U.S. EPA 2014 (Attachment 1)

1 See USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs) at Superfund Sites website for reference/ citation details. http://epa-bprg.ornl.gov/

PROTOCOL

Human Health Constituents of Potential Concern

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of human health constituents of potential concern (HH COPCs). The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

This protocol is considered the first step in the formal human health risk data evaluation process. It is implemented after the exposure groups are identified and the data are appropriately processed in accordance with established protocols pertaining to data grouping and processing (see Step 1 below).

Preliminary remediation goals (PRGs) for radiological constituents and regional screening levels (RSLs) for nonradiological constituents are risk-based thresholds that can be used to evaluate potentially contaminated waste sites. PRGs and RSLs are derived in accordance with the methodologies described in the Risk Assessment Guidance for Superfund (RAGS) documents published by USEPA. PRG activities and RSL concentrations are based on exposure pathways for which generally accepted methods, models, and assumptions have been developed.

- PRGs are activities that correspond to a one-in-one million [$1x10^{-6}$] cancer risk level.
- RSLs are concentrations that correspond to either a $1x10^{-6}$ risk level for carcinogens or a hazard quotient (HQ) of 0.1 or 1 for noncarcinogens. If a substance causes both cancer and noncancer (systemic) effects, the more stringent criteria shall take precedence.

USEPA provides various database tools with which to derive risk-based PRGs/RSLs, if needed, using standard default parameters and the latest toxicity values; these websites also allow the user to modify input parameters to create site-specific PRGs/RSLs. Details of the scenarios/exposure assumptions, etc., can be found at the USEPA websites that are described in the *Sources of Human Health Screening Values Protocol* (HH-1).

- *USEPA Preliminary Remediation Goals for Radionuclides (PRGs)* is the website tool used to obtain soil and tap water PRGs for radionuclides. For screening purposes, soil PRGs are used to screen sediment media and tapwater PRGs may be used to screen groundwater and surface water media. The website also publishes maximum contaminant levels (MCLs) for the evaluation of groundwater and surface water media.

- *USEPA Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRGs*) is the website tool used to obtain SPRGs for outdoor concrete slabs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs)* is the website tool used to obtain BPRGs for the interior of buildings for radionuclides.
- *USEPA Regional Screening Levels (RSLs)* is the website tool used to obtain soil and tap water RSLs for nonradionuclides. For screening purposes, soil RSLs are used to screen sediment and concrete media and tap water RSLs may be used to screen groundwater and surface water media. The website also publishes MCLs for the evaluation of groundwater and surface water media.

For the purposes of this protocol, the term PRG is used generically to include the terms SPRG and BPRG, unless otherwise noted. Standardized PRG/RSL tables can be used in all stages of the risk-decision making process. A copy of the PRG/RSL table(s) used to perform the screening described in this protocol will be provided in the appropriate regulatory document (e.g., Baseline Risk Assessment).

Details

Data Screening for Soil, Sediment or Concrete Media

Figure 1 is a flowchart of the HH COPC selection process for soil, sediment or concrete media described below. Table 1 is a sample HH COPC screening table.

Step 1: Data Preparation

Data for each constituent should be sorted by medium as described in the *Development of Exposure Groups Protocol* (DG-1). Data should be processed in accordance with the *Unit-Source Data Processing Protocol* (DP-1), *Unit-Background Data Processing Protocol* (DP-2), if appropriate and *Surrogates for Non-Detects Protocol* (DP-3). For any data which have qualifiers, determine if the qualified data should be retained. Do not eliminate data based on "J" qualifiers.

Calcium, magnesium, potassium and sodium are excluded from further evaluation because they are essential nutrients that are not considered toxic and do not have health-based limits.

Step 2: PRG/RSL Comparison

Use the residential soil PRGs/RSLs for unit soil, sediment, and concrete media.

For carcinogenic effects, compare the maximum activity/concentration of each constituent in each exposure group to the $1x10^{-6}$ PRG activity or RSL concentration.

For non-carcinogenic effects, compare the unit maximum concentration of each constituent in each exposure group to the HQ-level of 0.1 (RSL concentration x 0.1).

Retain the constituent for further analysis if its maximum value exceeds the appropriate PRG or RSL screening value. The constituent is eliminated from further evaluation if its maximum value is less than the PRG or RSL screening value.

Determine if the constituent is naturally occurring or anthropogenic. Anthropogenic constituents that exceed the PRG/RSL screen will be identified as HH COPCs (Step 5) and carried forward through a more detailed analysis of human health risk. Naturally occurring constituents that exceed the PRG/RSL screen shall proceed to Step 3.

Step 3: Background Comparison

For naturally occurring inorganics and radionuclide constituents, compare the maximum concentration to two times the average background concentration from the approved SRS soil background dataset (or unit-specific background) for each exposure group (WSRC 2006)[1].

For soils and sediments, the unit maximum value from the 0-1 foot (ft) depth interval is compared to two-times the average background value (0-1 ft interval) for a particular constituent.

For concrete media, the surficial maximum value (typically from the 0-0.5 inch interval) may be compared to two-times the 0-1 ft average background value for soils.

Retain the constituent for further analysis if its maximum value exceeds the background screening value. The constituent is eliminated from further evaluation if its maximum value is less than the background screening value.

Step 4: Re-inclusion Step

Consider whether any previously eliminated constituent should be re-included due to historical information or other considerations including mobility, bioaccumulation concern, persistence, and toxicity. Also, any member of a chemical class that has other members selected as COPCs should be retained (e.g., polychlorinated biphenyls, dioxins and furans).

Step 5: Final HH COPC Identification

The constituents retained at this point in the process are identified as HH COPCs. They will be carried forward through a more detailed analysis of human health risk (i.e., *Human Health Constituents of Concern Protocol* [HH-5]). If no HH COPCs have been identified at this point, then this part of the analysis is complete.

[1] WSRC 2006. *Background Soils Statistical Summary Report for the Savannah River Site,* ERD-EN-2005-0223, Revision 1, Washington Savannah River Company, Savannah River Site, Aiken, SC, Appendix B-1.

Data Screening for Groundwater or Surface Water Media

For groundwater, the maximum detected concentrations of each constituent are compared to drinking water MCLs. In the absence of an MCL, the tap water RSL/PRG is used as a screening threshold. Constituents that 1) exceed the MCL screen, or 2) do not have a MCL and exceed the risk-based threshold are further evaluated in the refinement of COCs step (i.e., Constituents of Concern (COC) Refinement Process Protocol [COC-1]).

For surface water, the maximum detected concentration of each constituent is compared to the drinking water MCL and ambient water quality criteria (AWQC, Consumption of Water plus Organism). In the absence of an MCL or AWQC, the tap water RSL/PRG is used as a screening threshold. Constituents that 1) exceed either the MCL or the AWQC screen, or 2) do not have an MCL or an AWQC and exceed the risk-based threshold are further evaluated in the refinement of COCs step (i.e., Constituents of Concern (COC) Refinement Process Protocol [COC-1]).

If no constituents exceed any of the screening comparisons, then this part of the analysis is complete. Table 2 is a sample comparison table for surface water media. (Note the groundwater table is similar to surface water but does not include an AWQC comparison).

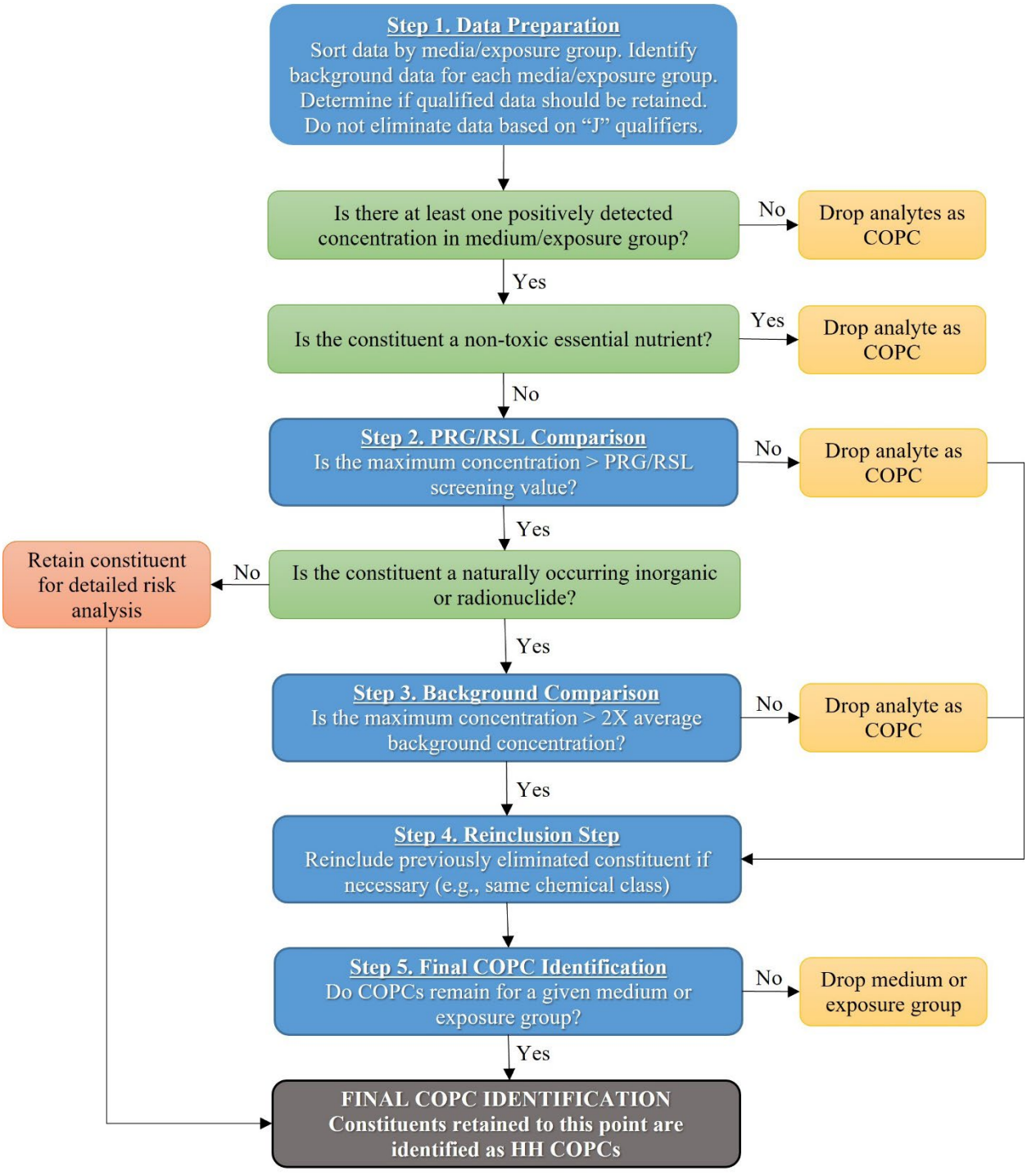


Figure 1. Flowchart of Human Health COPC Selection Process

This page is intentionally left blank.

Table 1. (Sample) Human Health COPC Screening for Surface Soil (0 to 0.3 m [0 to 1 ft])

Analyte	Detected Maximum Concentration	Qualifier	Human Health Screening Value[1]	Human Health Screening Value Source	Exceeds Human Health Screening Value?	2X Average Background Concentration[2]	Exceeds 2X Average Background?[3]	COPC?[4]
Inorganics *(mg/kg)*								
Constituent A	1.05E+04		7.61E+03	0.1xRSL	YES	1.30E+04	no	no
Constituent B	3.98E+00	J	3.90E-01	RSL	YES	2.60E+00	YES	**COPC**
Constituent C	3.82E+01		5.37E+02	0.1xRSL	no	4.58E+01	no	no
Constituent D	9.30E-01		1.54E+01	0.1xRSL	no	NA	NA	no
Constituent E	5.92E+02		NA	Nutrient[5]	no	4.88E+02	YES	no
Constituent F	4.32E+01		2.11E+02	RSL	no	2.96E+01	YES	no
Constituent G	4.30E+00		3.13E+02	0.1xPRG	no	6.16E+00	no	no
Organics *(mg/kg)*								
Constituent H	7.23E+02		1.24E+01	0.1xRSL	YES	NA	NA	**COPC**
Constituent I	1.35E-01	J	1.57E+02	0.1xRSL	no	NA	NA	no
Constituent J	6.54E+01	J	9.11E+00	RSL	YES	NA	NA	**COPC**
Constituent K	4.16E-02		7.33E+02	0.1xRSL	no	NA	NA	no
Constituent L	3.36E-03		1.51E+00	RSL	no	NA	NA	no
Pesticides/PCBs *(mg/kg)*								
Constituent M	4.89E+01		1.72E+00	RSL	YES	NA	NA	**COPC**
Constituent N	1.22E-03	J	1.83E+01	RSL	no	NA	NA	no
Radionuclides *(pCi/g)*								
Constituent O	1.35E+00		7.32E+02	PRG	no	2.14E+00	no	no
Constituent P	8.47E-01		8.19E+03	PRG	no	1.43E+00	no	no
Constituent Q	4.99E+02		2.79E+02	PRG	YES	1.06E+00	YES	**COPC**
Constituent R	1.94E+01	J	6.05E-02	PRG	YES	8.02E-01	YES	**COPC**
Constituent S	9.55E-01		4.63E+04	PRG	no	1.53E+00	no	no
Constituent T	1.38E+00		1.38E-01	PRG	YES	2.94E+00	no	no
Constituent U	8.47E-01		1.31E-02	PRG	YES	1.43E+00	no	no

1 - Nonradiological RSLs are generic residential soil values from the USEPA Regional Screening Levels table (date); radiological PRGs are site-specific residential soil values derived using the USEPA Preliminary Remediation Goals website calculator (date) and eliminating the fruit and vegetable consumption pathways. All other inputs are default values. Both websites were accessed on (date).

2 - Background screening values obtained from *Background Soils Statistical Summary Report for the Savannah River Site* (WSRC 2006), Table B-1 (0-1 ft interval).

3 - For screening purposes, maximum concentration of only the naturally-occurring (nonanthropogenic) constituents are compared to 2X average background concentration.

4 - Constituents identified as COPCs if the maximum detected concentration of the naturally occurring (nonanthropogenic) constituents exceeds the human health screening value and the 2X average background d concentration.

5 - Essential nutrients are not identified as COPCs, RSL not available.

NA - Not available

Table 2. (Sample) Surface Water Comparison to MCLs, AWQC, and RSLs/PRGs

Analyte	Detected Maximum Concentration	MCL	Result > MCL?	AWQC	Result > AWQC?	Tap Water RSL/PRG	Result > RSL/PRG?
Inorganics *(ug/L)*							
Constituent A	3.62E+00	6.0E+00	no	5.60E+00	no		
Constituent B	3.05E+00	1.0E+01	no	1.00E+01	no		
Constituent C	1.40E+00	4.0E+00	no	NA	---		
Constituent D	2.31E+01	5.0E+00	**YES**	NA	---		
Constituent E	1.47E+02	1.0E+02	**YES**	NA	---		
Constituent F	8.05E+02	NA	---	1.30E+03	no		
Constituent G	1.01E+00	2.0E+00	no	5.00E-02	**YES**		
Constituent H	5.80E+03	NA	---	NA	---	6.00E+03	no
Organics *(ug/L)*							
Constituent I	4.02E+00	2.0E-01	**YES**	3.80E-03	**YES**		
Constituent J	3.63E+01	5.0E+00	**YES**	2.50E+00	**YES**		
Constituent K	5.06E+02	1.0E+03	no	1.30E+03	no		
Pesticides/PCBs *(ug/L)*							
Constituent L	2.22E-01	2.0E+00	no	8.00E-04	**YES**		
Constituent M	1.16E-02	NA	---	NA	---	7.80E-03	**YES**
Radionuclides *(pCi/L)*							
Constituent N	2.30E+01	1.5E+01	**YES**	NA	---		
Constituent 0	1.37E+03	2.0E+04	no	NA	---		

MCL = Maximum Contaminant Level

AWQC - Ambient Water Quality Criteria (For Consumption of Water & Organism)

RSL = Tap water Regional Screening Level

PRG = Tap water Preliminary Remediation Goal

NA - Not available

Constituents to be carried forward for further evaluation are highlighted in bold **YES.**

PROTOCOL

Human Health Constituents of Concern

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of human health constituents of concern (HH COCs). The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

This protocol is to be applied to constituents when a risk (hazard) estimate is needed. Typically it is implemented after the *Human Health Constituents of Potential Concern Protocol* (HH COPCs) has been implemented (HH-4); however it can be used on the entire list of detected analytes if the formal COPC screening has not been performed.

Preliminary remediation goals (PRGs) for radiological constituents and regional screening levels (RSLs) for nonradiological constituents are risk-based thresholds that can be used to evaluate potentially contaminated waste sites. PRGs and RSLs are derived in accordance with the methodologies described in the Risk Assessment Guidance for Superfund (RAGS) documents published by USEPA. PRG activities and RSL concentrations are based on pathways for which generally accepted methods, models, and assumptions have been developed.

- PRGs are activities that correspond to a one-in-one million [$1x10^{-6}$] cancer risk level.
- RSLs are concentrations that correspond to either a $1x10^{-6}$ risk level for carcinogens or a hazard quotient (HQ) of 1 for noncarcinogens. If a substance causes both cancer and noncancer (systemic) effects, the most stringent criteria shall take precedence.

USEPA provides various database tools with which to derive risk-based PRGs/RSLs, if needed, using standard default parameters and the latest toxicity values; these websites also allow the user to modify input parameters to create site specific PRGs/RSLs. Details of the scenarios/exposure assumptions, etc., can be found at the USEPA websites that are described in the *Sources of Human Health Screening Values Protocol* (HH-1).

- *USEPA Preliminary Remediation Goals for Radionuclides (PRGs)* is the website tool used to obtain soil and tap water PRGs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRGs*) is the website tool used to obtain SPRGs for outdoor concrete slabs for radionuclides.

- *USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs)* is the website tool used to obtain BPRGs for the interior of buildings for radionuclides.
- *USEPA Regional Screening Levels (RSLs)* is the website tool used to obtain soil and tap water RSLs for nonradionuclides.

For the purposes of this protocol, the term PRG is used generically to include the terms SPRG and BPRG, unless otherwise noted. Standardized PRG/RSL tables can be used in all stages of the risk decision-making process. A copy of the PRG/RSL table(s) used to calculate the risk/hazard estimates described in this protocol will be provided in the appropriate regulatory document (e.g., Baseline Risk Assessment).

Details

(1) Segregate carcinogenic (risk) and non-carcinogenic (hazard) constituents.

(2) For noncarcinogens, calculate the hazard quotient based on the following equation:

$$HQ = ([EPC] / [RSL])$$

HQ = hazard quotient

EPC = exposure point concentration is defined as the lesser of the maximum detected concentration and the 95% UCL on the mean concentration

RSL = value for nonradiological constituents (RSL for concrete media = 10x soil RSL)

Sum the HQs to obtain a Total Media Hazard Index (HI). If the Total Media HI is less than one, then no COCs are identified. If the Total Media HI is greater than one, then the constituents are segregated based on relevant target organs. Sum the HQs according to target organs. Constituents are identified as COCs if the Total Organ HQ is greater than 0.1 and the Total Organ HI is greater than one. If the Total Organ HI is less than one, then the constituents are not identified as HH COCs.

(3) For carcinogens, calculate the risk based on the following equation:

$$\text{risk estimate} = ([EPC] / [PRG \text{ or } RSL]) \times 1E\text{-}06$$

EPC = exposure point concentration is defined as the lesser of the maximum detected concentration and the 95% upper confidence limit (UCL) on the mean concentration

PRG = value for radiological constituents (includes SPRG and/or BPRG)

RSL = value for non-radiological constituents (RSL for concrete media = 10x soil RSL)

Sum the risk estimates of the chemical constituents to obtain a Total Chemical Risk estimate. Sum the risk estimates of the radiological constituents to obtain a Total Radiological Risk estimate. Sum the Total Chemical Risk estimate and the Total Radiological Risk estimate to

obtain a Total Media Risk estimate. Constituents with an individual cancer risk greater than 1E-06 are identified as HH COCs.

Table 1 is a sample Human Health Risk/Hazard Calculation table.

(4) Constituents retained to this point in the process are identified as HH COCs. They will be carried forward to an uncertainty discussion (i.e., *Constituents of Concern Refinement Process Protocol* [COC-1]). If no HH COCs have been identified at this point, then this part of the analysis is considered complete.

Table 1. (Sample) Human Health Risk/Hazard Calculation for Surface Soil (0 to 0.3 m [0 to 1 ft])

Residential Scenario

Analyte[1]	EPC[2] (mg/kg or pCi/g)	Residential RSL/PRG[3]	Residential Hazard Estimate[4]	Residential Risk Estimate[5]	Target Organ	COC?[6]
Noncarcinogenic Hazard Estimate						
Constituent A	8.11E+03	7.74E+04	1.05E-01		Neurological	no
Constituent B	4.53E+00	3.49E+01	1.30E-01		Dermal	no
Constituent C	2.48E+01	3.48E+03	7.12E-03		Other	no
Constituent D	1.20E+00	2.34E+01	5.15E-02		Hematological	no
Constituent E	1.61E+04	5.48E+04	2.93E-01		Hepatic	no
Constituent F	1.32E+02	1.83E+03	7.21E-02		Neurological	no
Constituent G	3.78E+00	7.82E-01	4.83E+00		Hematological	**YES**
Constituent H	4.93E+01	3.93E+02	1.25E-01		Dermal	no
	Total Hazard Index =		**5.72E+00**			
Carcinogenic Risk Estimate						
Constituent I	4.53E-01	6.77E-01		6.69E-07		no
Constituent J	2.48E+01	3.01E-01		8.24E-05		**YES**
	Total Chemical Risk =			**8.31E-05**		
Rad Constituent K	5.45E-01	3.30E-02		1.65E-05		**YES**
Rad Constituent L	2.48E+01	1.44E-01		1.72E-04		**YES**
Rad Constituent M	3.03E+00	9.85E+00		3.08E-07		no
Rad Constituent N	2.60E+00	1.25E-02		2.08E-04		**YES**
	Total Radiological Risk =			**3.97E-04**		
	Total Media Risk =			**4.80E-04**		

1 - Analytes that were identified as COPCs.
2 - EPC - reasonable maximum exposure (RME) exposure point concentration (EPC) is the lesser of the maximum detected concentration and the 95% upper confidence limit (UCL) on the mean concentration.
3 - Nonradiological RSLS are residential soil site-specific values from the generic USEPA Regional Screening Levels (RSLs) Table, (date). Radiological PRGs are residential soil site-specific values derived using the USEPA Radionuclide Preliminary Remediation Goals (PRGs) for Superfund website calculator (date) and eliminating the fruit and vegetable pathways. All other inputs are default parameters; website accessed (date).
4 - Residential Hazard Estimate = EPC/RSL.
5 - Residential Risk Estimate = (EPC/[RSL or PRG])x1E-06.
6 - For noncarcinogens, no constituents are identified as COCs if the total media HI<1. If the total media HI≥1, then the constituents are segregated based on relevant target organs. Hazard quotients (HQs) are summed according to target organs (see table below). Constituents are identified as COCs if the total organ HQ>0.1 and the total organ HI>1. For carcinogens, constituents are identified as COCs if the individual cancer risk≥1E-06.

Neurological	Constituent A	1.05E-01
	Constituent F	7.21E-02
	Total Neurological	**1.77E-01**

Hematological	Constituent D	5.15E-02
	Constituent G	4.83E+00
	Total Hematological	**4.89E+00**

Dermal	Constituent B	1.30E-01
	Constituent H	1.25E-01
	Total Dermal	**2.55E-01**

Hepatic	Constituent E	2.93E-01
	Total Hepatic	**2.93E-01**

Other	Constituent C	7.12E-03
	Total Other	**7.12E-03**

PROTOCOL

Human Health Preliminary Remedial Goals

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of human health preliminary remedial goals (HH PRGs) to identify a range of risk-based cleanup levels for remedial decision making. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

This protocol applies to the human health refined constituents of concern (HH RCOCs) that are identified after performing an uncertainty analysis per the *Constituents of Concern Refinement Process Protocol* (COC-1).

Details

(1) Calculate PRG cleanup levels at the 1×10^{-6}, 1×10^{-5}, and 1×10^{-4} risk level for carcinogenic constituents, for the exposure scenarios of interest.*

(2) Calculate PRG cleanup levels at the 0.1, 1, and 3 hazard quotient (HQ) levels for noncarcinogenic constituents, for the exposure scenarios of interest.*

Table 1 is a sample Preliminary Remedial Goals table for an Industrial Worker exposure scenario.

Table 1. (Sample) Preliminary Remedial Goals

RCOC	Units	Industrial Worker 1E-06	Industrial Worker 1E-05	Industrial Worker 1E-04	Industrial Worker HQ= 0.1	Industrial Worker HQ = 1	Industrial Worker HQ = 3
Constituent A	mg/kg	1.6	16	160	25.6	256	768
Constituent B	mg/kg	--	--	--	666	6660	19980
Constituent C	pCi/g	0.112	1.12	11.2	--	--	--

*Note - Preliminary remediation goals (PRGs), outside surface PRGs (SPRGs), inside building PRGs (BPRGs) and regional screening levels (RSLs) as described in the *Sources of Human Health Screening Values Protoocol, HH-1,* are useful tools for identifying the initial cleanup goals at a site and can be used as a basis to establish risk-based cleanup levels.

This page is intentionally left blank.

PROTOCOL

Evaluation of Principal Threat Source Material (PTSM) at SRS Waste Units

Introduction

This protocol has been developed to provide guidance on the evaluation of source materials at Savannah River Site (SRS) waste units, specifically presenting a methodology for determining whether principal threat source material (PTSM) is present.

The concept of principal threat waste and low level threat waste as developed by the U.S. Environmental Protection Agency (USEPA) in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300.430(a)(1)(iii)) is to be applied on a site-specific basis when characterizing source material. Source materials are those materials that include or contain hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to groundwater, surface water, or air, or that act as a source for direct exposure (USEPA 1991). Source characterizations are necessary to determine whether the source(s) can be designated as PTSM, low-level threat source material (LLTSM), or non-hazardous materials. The NCP expectations for addressing PTSM and LLTSM are to:

- Use treatment to address the principal threats posed by a unit, wherever practicable.
- Use engineering controls (e.g., containment) for wastes that pose a relatively low long-term threat or where treatment is impracticable.
- Use a combination of methods where appropriate.
- Use institutional controls as appropriate for short- and long-term management to prevent or limit exposure.

This protocol reflects the U. S. Department of Energy (USDOE), USEPA, and South Carolina Department of Health and Environmental Control (SCDHEC) expectations with respect to defining and managing PTSM at SRS (WSRC 2005). The following discussion is divided into three sections: 1) evaluation of source material at SRS, 2) determination of PTSM, and 3) expectation for addressing PTSM in remedial alternative development and selection.

Evaluation of Source Material at SRS

The determination of whether the source materials at a waste unit would be classified as PTSM is based principally on USEPA guidance (USEPA 1991). In this guidance, the USEPA defines principal threat wastes as "those source materials considered to be highly toxic or mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur." They include liquids and other highly mobile materials (e.g., materials that are released from surface soil due to volatilization, leaching, or surface runoff) or materials having high concentrations of toxic compounds. No "threshold level" of toxicity/risk has been established to equate to "principal threat." However, the guidance does state that treatment alternatives for source materials should generally be evaluated where the combined toxicity and mobility pose a potential risk of 1×10^{-3} or greater.

The USEPA, SCDHEC, and USDOE evaluated the USEPA guidance with respect to toxicity and contaminant migration analyses performed at SRS (WSRC 2005). In practice, the SRS risk assessment and contaminant migration evaluations identify constituents of concern (COCs) associated with source material or impacted media and determine the associated risk or potential impact to groundwater. If threshold risk levels are exceeded or groundwater protection standards are predicted to be contravened in less than 1000 years, these problems are identified and an evaluation of remedial alternatives is conducted in the Feasibility Study (FS). Since the risk assessment does not evaluate human receptor exposure to subsurface soils, further evaluation is needed to account for highly toxic source material or contaminated soils at depth that would result in unacceptable risk should exposure occur. However, since the existing program determines contaminant migration COCs for the entire soil column (vadose zone) in the remedial investigation, and addresses these COCs in the FS with evaluation of at least one treatment or removal alternative, the mobility aspect of PTSM is already being addressed as part of the Remedial Investigation/Feasibility Study (RI/FS) process. Therefore, a separate quantitative determination of whether PTSM exists based on mobility as part of this protocol is not required.

Determination of PTSM

Initially, a qualitative assessment of the source material(s) can be used to determine if the source material should be considered PTSM. These source materials would include containerized liquid wastes (e.g., drums) or non-aqueous phase liquids (NAPL) (e.g. perched dense NAPLs in the vadose zone), and highly toxic solid wastes such as polychlorinated biphenyl (PCB) transformers or lead batteries.

In order to determine whether contaminated source material/soils/sediment should be preliminarily considered PTSM, a simple quantitative assessment evaluating the toxicity of the source is used as described in the following paragraphs.

A source term concentration is established for all the unit-specific constituents (USC) identified. The samples collected from within the source material area or zone of highly contaminated soils/sediment are considered the source group samples. Sufficient process knowledge and

characterization is required to adequately define the source term concentration for PTSM determination. The PTSM evaluation is applicable to the entire soil column. Examples include the first few feet of sediment in the bottom of a seepage or discharge basin, the burn/sludge zone at the base of a burning trench, contaminated concrete in a sump, or sludge/sediment in a pipe. Summary statistics (i.e., the mean value, the 95 percent upper confidence limit on the mean [95% UCL] value, and the maximum value) are compiled for each USC associated with each source group (refer to *Development of Exposure Groups Protocol*, DG-1 and *Unit-Specific Constituents Protocol*, USC-1). The PTSM exposure point concentration (EPC) is the lower of the 95% UCL or the maximum value and is used to represent the overall source (refer to *Unit Source Data Processing Protocol*, DP-1).

In determining whether the source should be considered PTSM, the evaluation considers the cumulative effects of both the potential risk from carcinogenic constituents and the adverse health effects from noncarcinogens to human receptors. Because the most likely future land use scenario for most SRS operable units being evaluated is industrial, the toxicity assessment of the source material is based on the potential exposure of a future on-unit industrial worker. If appropriate, other exposure scenarios should be considered on a case-by-case basis, as agreed to by the project-specific core team.

Preliminary remediation goals (PRGs) for radiological constituents and regional screening levels (RSLs) for nonradiological constituents are risk-based thresholds that can be used to evaluate potentially contaminated sites. USEPA provides various database tools with which to derive risk-based PRGs/RSLs using standard default parameters and the latest toxicity values; these websites also allow the user to modify input parameters to create site specific PRGs/RSLs. Details of the scenarios/exposure assumptions, etc., can be found at the USEPA websites that are described in the *Sources of Human Health Screening Values Protocol (HH-1)*.

- *USEPA Preliminary Remediation Goals for Radionuclides (PRGs)* is the website tool used to obtain soil and tap water PRGs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Outdoor Surfaces (SPRGs*) is the website tool used to obtain SPRGs for outdoor concrete slabs for radionuclides.
- *USEPA Preliminary Remediation Goals for Radionuclides in Buildings (BPRGs)* is the website tool used to obtain BPRGs for the interior of buildings for radionuclides.
- *USEPA Regional Screening Levels (RSLs)* is the website tool used to obtain soil and tap water RSLs for nonradionuclides.

For the purposes of this protocol, the term PRG is used generically to include the terms SPRG and BPRG. The source material is preliminarily considered to be PTSM if the cumulative risk exceeds one of the following toxicity threshold criteria:

- Carcinogens - greater than 1×10^{-3} industrial worker risk
- Noncarcinogens – industrial worker hazard index (HI) greater than 10

For carcinogens, the individual risk is calculated by multiplying the ratio of the EPC over the PRG or RSL by 1 x 10^{-6}. Each of these risks is summed to calculate the cumulative carcinogenic risk of the source. For noncarcinogens, an individual hazard quotient (HQ) is equal to the ratio of the EPC over the RSL. These HQs are summed to derive the cumulative HI. The maximum detected concentration may be used as a conservative EPC in the preliminary data screening step.

An uncertainty analysis will be conducted in the RI to further evaluate the constituents and source(s) that exceed the PTSM toxicity criteria. This analysis is intended to help the project-specific core team make a final determination as to the presence of PTSM at the unit. Some examples where it may not be appropriate to identify the source as PTSM include: (1) if the source defined as PTSM is of very limited extent or volume, (2) if the source term concentration appears skewed based on a single value, (3) if a published toxicity value is undergoing additional evaluation, or (4) if the HI exceeds 10 based on the cumulative effects of noncarcinogens that effect different target organs.

Remedial Alternative Expectations

For those source materials that are considered to be PTSM, the remedial action objectives (RAOs) addressing PTSM should be written in a manner consistent with USEPA Guidance (USEPA 1988). For example, "prevent potential future exposure of an industrial worker to PTSM levels of uranium-238 in concrete at depth," rather than "treat or remove PTSM levels of uranium-238 in concrete to the extent practicable." This will allow a full range of alternatives to be considered by the core team in the remedy selection process. Treatment (such as soil vapor extraction, biodegradation, in-situ oxidation, stabilization, grouting, etc.) and off-site disposal alternatives are preferred in the NCP for addressing principal threats. In addition, containment and institutional controls can be evaluated as part of the nine criteria analysis conducted in the FS, considering the level of toxicity/risk, mobility, the volume of the PTSM, the depth below the surface (likelihood of exposure), the likely land-use scenario in the area, and any land use controls that will be required as part of the overall remedy.

References

USEPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final, (*October 1988), EPA 540/G-89/004, OSWER 9355.3-01

USEPA, 1991. *A Guide to Principal Threat and Low Level Threat Wastes*, U.S. Environmental Protection Agency OSWER Superfund Publication 9380.3-06FS.

WSRC, 2005. *Programmatic Scoping Summary for Review of PTSM Determination (U),* ERD-EN-2005-0151, September 7, 2005 (Final), Westinghouse Savannah River Company, Savannah River Site, Aiken, SC

PROTOCOL

Sources of Ecological Screening Values

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It identifies sources of the ecological screening values (ESVs) and refinement screening values (RSVs) used in the ecological risk assessment (ERA) process for the various media of concern. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

Details

The purpose of this protocol is to identify the sources and website links for the various literature-based screening values and outline the methodology to derive site-specific screening values used in the ecological risk evaluation process. The ESV screening is the initial step in the ERA data screening process. Both the ESVs and RSVs support the other ERA protocols: *Ecological Receptors and Measurement/Assessment Endpoints* (ECO-2), *Constituents of Potential Ecological Concern* (ECO-3), *Ecological Constituents of Potential Concern/ Constituents of Concern* (ECO-4), *Ecological Site-Specific Data/Studies* (ECO-5), and *Ecological Preliminary Remedial Goals* (ECO-6). The following references are the primary sources of the screening values for the various environmental media:

- *USEPA Regional Ecological Risk Assessment Supplemental Guidance* provides threshold values for hazardous waste sites for soil, sediment, and surface water for non-radiological constituents. https://www.epa.gov/risk/regional-ecological-risk-assessment-era-supplemental-guidance. The citation and link to the pdf version of the threshold document is provided below.
    - USEPA, 2018. *Region 4 Ecological Risk Assessment Supplemental Guidance March 2018 Update* U.S. Environmental Protection Agency, Scientific Support Section, Superfund Division, Atlanta, GA https://www.epa.gov/sites/default/files/2018-03/documents/ era_regional_supplemental_guidance_report-march-2018_update.pdf
        - The soil screening values typically address toxicity through direct exposure (i.e., toxicity to soil invertebrates such as earthworms and plants) and/or ingestion/dietary exposure to wildlife receptors. The hierarchy for soil benchmarks is as follows: EPA Ecological Soil Screening Levels (SSLs), U.S. Department of Energy Laboratories (i.e., Los Alamos National Laboratory [LANL] and Oak Ridge

National Laboratory), and equilibrium partitioning modeled values for organic chemicals. Only screening level thresholds are provided for soil media.

- The sediment screening values are derived from the statistical interpretation of effects databases obtained from the literature. These benchmarks are generally based on observations of direct toxicity to benthic organisms. ESVs (for the screening level assessment) and RSVs (for the refinement level assessment) are provided.
- Surface water values are compiled based on the following hierarchy: National Recommended Surface Water Quality Criteria (NWQC), Tier 2 values or equivalent from the Great Lakes Initiative, state surface water standards, Suter and Tsao 1996 values, Canadian water quality values, the minimum value from either the Target Lipid Model or Ecological Structure Activity Relationship model, and the Office of Pesticide Programs Aquatic Life Benchmarks. In general, the most conservative is selected as the ESV. For the NWQC, the chronic AWQC value for the protection of aquatic life is used as the screening value. Chronic values are used for both the screening and refinement level assessments.

- *ECORISK Database Tool developed by Los Alamos National Laboratory* documents and archives ecological screening levels. The LANL database tool includes thresholds for soil, sediment, and surface water. LANL develops literature-based toxicity reference values (TRVs) for various chemical exposure pathways, and using the derived TRVs as well as dose rates (for radionuclides) and other benchmarks, LANL calculated No Effect and Low Effect ecological screening levels (ESLs) for various media and receptors. Details of this process are described in Toxicity Reference Value Development Methods for the Los Alamos National Laboratory, Revision 1 (LANL 2014). The ECORISK Database Tool compiles the resulting No Effect and Low Effect ESLs by media (soil, sediment, and surface water) and receptor. The minimum ESL available from all receptors for a given media and constituent are used as the threshold level as follows: the minimum No Effect ESL is used as the threshold for the screening level assessment, and the minimum Low Effect ESL is used as the threshold for the refinement level assessment.

  - LANL, 2014. *Toxicity Reference Value Development Methods for the Los Alamos National Laboratory*, Rev.1, Los Alamos National Laboratory Environmental Programs Directorate, Los Alamos, NM

  - LANL, 2017. *Ecorisk Database,* Release 4.1, Los Alamos National Laboratory, Los Alamos, NM https://rais.ornl.gov/documents/ECO_BENCH_LANL.pdf (ECO_ BENCH_LANL.pdf pages 481-520). (The most current version of the database should be used.)

- SCDHEC, 2020. *Water Classifications & Standards*, R. 61-68, South Carolina Department of Health and Environmental Control, Columbia, SC
  - *Water Classifications and Standards*, R. 61-68 (freshwater aquatic life chronic values) regulation is a source of threshold values for the assessment of surface

water. These thresholds are used for both the screening level and refinement level assessments. (The most current version of the regulation should be used.) The link to the pdf version of the standards is: https://scdhec.gov/sites/default/files/media/document/R.61-68_0.pdf (R.61_68_0.pdf, Appendix, and Attachments 1, 2, and 3, pages 39-59)

Derivation of Site-Specific Screening Values

The screening values derived from these sources are compared in a tabular format. All ESVs/RSVs available for a given constituent are identified by source, with the most conservative (i.e., lowest selected screening value) highlighted in italics. Sample tables for each environmental media type are provided below.

Soil

Table 1. Soil ESV (No Effect Screening Level) Sample Table

Analyte (mg/kg, pCi/g)	EPA R4 Soil[1]	LANL Soil[2]	ESV[3]
Constituent A	2.90E+01	*6.80E+00*	**6.80E+00**
Constituent B	*8.80E-01*	*8.80E-01*	**8.80E-01**
Constituent C	1.80E+01	*6.90E+00*	**6.90E+00**
Constituent D	3.30E+02	*1.10E+02*	**1.10E+02**
Constituent E	*1.20E-01*	2.40E+01	**1.20E-01**
Constituent F	*1.10E+00*	2.40E+01	**1.10E+00**

1 - Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
2 - Los Alamos National Laboratory No Effect ESL for Soil Media (LANL 2017)
3 - Ecological Screening Value = lowest (most conservative) screening value from the values shown in italics

Table 2. Soil RSV (Low Effect Screening Level) Sample Table

Analyte (mg/kg, pCi/g)	EPA R4 Soil[1]	LANL Soil[2]	RSV[3]
Constituent A	NA	*9.00E+00*	**9.00E+00**
Constituent B	NA	*8.80E+00*	**8.00E+00**
Constituent C	NA	*6.90E+01*	**6.90E+01**
Constituent D	NA	*1.80E+02*	**1.80E+02**
Constituent E	NA	*6.80E+01*	**6.80E+01**
Constituent F	NA	*2.40E+02*	**2.40E+02**

1 - Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
2 - Los Alamos National Laboratory Low Effect ESL for Soil Media (LANL 2017)
3 - Refinement Screening Value = lowest (most conservative) screening value from the values shown in italics

Sediment/Soil

Table 3. Sediment/Soil ESV (No Effect Screening Level) Sample Table

Analyte (mg/kg, pCi/g)	EPA R4 Sediment[1]	EPA R4 Soil[2]	LANL Sediment[3]	LANL Soil[4]	ESV[5]
Constituent A	*2.50E+04*	---	---	---	**2.50E+04**
Constituent B	1.61E+00	2.90E+01	*5.70E-02*	6.80E+00	**5.70E-02**
Constituent C	2.00E+00	*2.70E-01*	5.00E+01	2.40E+00	**2.70E-01**
Constituent D	9.80E+00	1.80E+01	9.70E+00	*6.80E+00*	**6.80E+00**
Constituent E	*2.00E+01*	3.30E+02	1.50E+02	1.10E+02	**2.00E+01**
Constituent F	1.80E-01	1.10E+00	*1.70E-01*	2.40E+01	**1.70E-01**

1 - Tables 2a, 2b, and 2c in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
2 - Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
3 - Los Alamos National Laboratory No Effect ESL for Sediment Media (LANL 2017)
4 - Los Alamos National Laboratory No Effect ESL for Soil Media (LANL 2017)
5 - Ecological Screening Value = lowest (most conservative) screening value from the values shown in italics

Table 4. Sediment/Soil RSV (Low Effect Screening Level) Sample Table

Analyte (mg/kg, pCi/g)	EPA R4 Sediment[1]	EPA R4 Soil[2]	LANL Sediment[3]	LANL Soil[4]	RSV[5]
Constituent A	*5.80E+04*	---	---	---	**5.80E+04**
Constituent B	1.61E+00	NA	*5.70E-01*	9.00E+00	**5.70E-01**
Constituent C	2.50E+01	NA	5.00E+02	*2.40E+01*	**2.40E+01**
Constituent D	*3.30E+01*	NA	*3.30E+01*	6.80E+01	**3.30E+01**
Constituent E	*6.00E+01*	NA	3.00E+02	2.60E+02	**6.00E+01**
Constituent F	*1.65E+00*	NA	1.70E+00	2.40E+02	**1.65E+00**

1 - Tables 2a, 2b, and 2c in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
2 - Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
3 - Los Alamos National Laboratory Low Effect ESL for Sediment Media (LANL 2017)
4 - Los Alamos National Laboratory Low Effect ESL for Soil Media (LANL 2017)
5 – Refinement Screening Value = lowest (most conservative) screening value from the values shown in italics

Surface Water

Table 5. Surface Water ESV or RSV Sample Table

Analyte (µg/L, pCi/L)	SCDHEC WQS[1]	EPA R4 Surface Water[2]	LANL Surface Water[3]	ESV or RSV[4]
Constituent A	---	*8.70E+01*	5.30E+02	**8.70E+01**
Constituent B	---	1.10E+01	*6.60E-01*	**6.60E-01**
Constituent C	*1.00E-01*	2.50E-01	2.80E-01	**1.00E-01**
Constituent D	---	*1.16E+05*	---	**1.16E+05**
Constituent E	*1.10E+01*	*1.10E+01*	*1.10E+01*	**1.10E+01**
Constituent F	*2.90E+00*	9.00E+00	5.00E+00	**2.90E+00**

1 - SCDHEC, R61-68, Water Classifications and Standards, chronic values for freshwater aquatic life (2020)
2 - Table 1a in EPA Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA 2018)
3 - Los Alamos National Laboratory for No Effect ESL for Surface Water Media (LANL 2017)
4 - Ecological Screening Value or Refinement Screening Value = lowest (most conservative) screening value from the values shown in italics

This page is intentionally left blank.

PROTOCOL

Ecological Receptors and Measurement/Assessment Endpoints

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides details on the receptors used for ecological risk evaluation. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

The receptors identified in this protocol are representative of the various receptors and ecological niches that are used to derive the literature-based screening values described in the *Sources of Ecological Screening Values Protocol* (ECO-1). Since the chosen ecological screening values (ESVs) and refinement screening values (RSVs) are based on the minimum thresholds for a given constituent, receptors with screening levels above those conservative thresholds are also considered protected. The screening level thresholds are derived from the following:

- *USEPA Region 4 Ecological Risk Assessment Supplemental Guidance* provides threshold values for hazardous waste sites for soil, sediment, and surface water for non-radiological constituents (USEPA 2018).
- *ECORISK Database Tool developed by Los Alamos National Laboratory* provides threshold values for soil, sediment, and surface water for non-radiological and radiological constituents (LANL 2017).
- *South Carolina Department of Health and Environmental Control, R.61 68, Water Classifications and Standards* (freshwater aquatic life chronic values) regulation is a source of nonradiological threshold values for the assessment of surface water (SCDHEC 2020).

Details - Receptors

USEPA Region 4 Ecological Risk Assessment Supplemental Guidance

- Soil – Screening levels identified in Table 3 of the guidance document are the lowest (most conservative) of the following receptors:

  Terrestrial Plants

  Soil Invertebrates

  Mammalian Herbivore (Meadow vole)

Mammalian Ground Insectivore (Short-tailed shrew)

Mammalian Carnivore (Long-tailed weasel)

Avian Herbivore (Mourning dove)

Avian Ground Insectivore (American woodcock)

Avian Carnivore (Red-tailed hawk)

- Sediment – ESV and RSVs identified in Table 2 of the guidance document

  Sediment-dwelling organisms

- Surface Water – freshwater screening values (chronic) identified in Table 1 of the guidance document

  Aquatic organisms

ECORISK Database Tool

No Effect Ecological Screening Levels (ESLs) and Low Effect ESLs identified in the database are the lowest (most conservative) of the following receptors:

- Soil

  Terrestrial Autotroph- producer (Generic plant)

  Soil-dwelling invertebrates (Earthworm)

  Avian herbivore (American robin)

  Avian insectivore (American robin)

  Avian omnivore (American robin)

  Avian insectivore / carnivore (American kestrel)

  Avian top carnivore (American kestrel)

  Mammalian herbivore (Mountain cottontail rabbit)

  Mammalian insectivore (Montane shrew)

  Mammalian omnivore (Deer mouse)

  Mammalian insectivore (Montane shrew)

  Mammalian top predator (Gray fox)

- Sediment

  Aquatic community organisms – sediment

  Avian aerial insectivore Violet (Green swallow)

  Mammalian aerial insectivore (Occult little brown myotis bat)

Aquatic autotroph- producer (Algae, rads only)

Aquatic herbivore- grazer (Aquatic snails, rads only

Aquatic omnivore/herbivore (Daphnids, rads only)

Aquatic intermediate carnivore (Fish, rads only)

- Surface Water

  Aquatic community organisms - water

  American robin (water)

  American kestrel (water)

  Mountain cottontail rabbit (water)

  Deer mouse (water)

  Montane shrew (water)

  Gray fox (water)

  Algae (rads only)

  Aquatic snails (rads only)

  Daphnids (rads only)

  Fish (rads only)

SCDHEC R.61 68, Water Classifications and Standards

- Surface Water

  Aquatic organisms

Details - Measurement/Assessment Endpoints

Assessment endpoints are tailored to groups of organisms with similar feeding strategies and/or exposure scenarios (i.e., ecological niche) appropriate for the operable unit (OU). Based on these considerations, typical assessment and measurement endpoints and their representative receptors are discussed below:

- Protection of terrestrial autotrophs (plants) to maintain habitat structure and functional base for terrestrial animals. Plants are a food source for many animals and have direct exposure to contaminated soil. The use of a "generic" plant as receptor is indicative of the broad concern for plants in general and typically only applies if there are threatened, endangered or sensitive (TES) species present within the exposure area. The measurement endpoint is a comparison of the measured constituent concentration in soil to generic plant toxicity benchmarks. This preliminary comparison is expressed as a hazard quotient (HQ) calculation based on the screening of OU data.

- Protection of soil-dwelling invertebrate communities to maintain species diversity and nutrient cycling. Soil-dwelling invertebrate communities are selected because the soil invertebrate community is ecologically important, is susceptible to constituents in soil, and may be exposed at the waste unit. The soil-dwelling invertebrate community is essential for decomposition of detritus, for energy and nutrient cycling, and is an important component of the diet of insectivorous mammals and birds. Earthworms are chosen as the representative species of soil-dwelling invertebrates because they are important in promoting soil fertility, are highly exposed to soil constituents, and toxicity information is available. The measurement endpoint is a comparison of the measured constituent concentration in soil-to-earthworm toxicity benchmarks. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of insectivorous, herbivorous, and omnivorous bird communities to ensure that exposure of contaminants in prey, forage, surface water, and soils does not have a negative impact on growth, survival, and reproduction. Insectivorous birds are ecologically important because they help to control the size of the terrestrial invertebrate population that might otherwise damage populations of plant primary producers. American robins are chosen as the representative terrestrial species because they are representative of birds that forage for ground-dwelling invertebrates and fruits, with a relatively high potential exposure to contaminants from its diet. The American robin is considered in several functional roles for avian receptors: an insectivore, herbivore, and omnivore. They also ingest soil during feeding, including soil within the bodies of earthworms and other prey. In addition, the violet-green swallow is selected as the representative avian aerial insectivore because 100 percent of its diet can be assumed to come from emergent aquatic insects, which allows for the consideration of bioaccumulation from aquatic sources to a high-level avian receptor. These preliminary comparisons are expressed as a HQ calculation based on the screening of OU data.

- Protection of carnivorous bird communities to ensure that exposure of contaminants in prey does not have a negative impact on growth, survival, and reproduction. American kestrels are selected as the representative species because abundant information has been gathered concerning the kestrel's biology and it represents an organism with high susceptibility to contaminant biomagnification from soil via terrestrial pathways. The American kestrel is considered in two functional roles for avian receptors, intermediate carnivore, and top carnivore. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of herbivorous mammal communities to ensure that exposure of contaminants in forage and soils does not have a negative impact on growth, survival, and reproduction. Herbivorous mammals are ecologically important because they provide a food base for higher trophic level receptors and are susceptible to soil constituents within the waste unit. Rabbits are chosen as the representative species of herbivorous mammals because they are exposed to soil constituents by their consumption of plant material, and they ingest soil during feeding. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of insectivorous mammal communities to ensure that exposure of contaminants in prey, forage, and soils does not have a negative impact on growth or survival. Insectivorous mammals are ecologically important because they help to control the size of the terrestrial invertebrate population that might otherwise damage populations of plant primary producers. They also are susceptible to soil constituents within the waste unit. Shrews are chosen as the representative species of the insectivorous mammals because they are highly exposed to constituents by their consumption of large quantities of terrestrial invertebrates. They also ingest soil during feeding, including soil within the bodies of earthworms and other prey. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of omnivorous mammal communities to ensure that exposure of contaminants in prey, forage, and abiotic media does not have a negative impact on growth, survival, and reproduction. Mammalian omnivores are ecologically important because they consume a variety of small mammals and plants, helping balance the populations of terrestrial invertebrates, rodents, and other small mammals as well as disperse seeds for plant reproduction. They also are susceptible to soil constituents at the waste unit. The mouse was chosen as the representative receptor because of its omnivorous food habits and largely to represent the importance of rodents as a food source for higher consumers (carnivores and omnivores), making it important in the functional food web. They are ubiquitous, abundant, and ingest soil during feeding, including soil within the bodies of earthworms and other prey. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of aerial insectivorous mammal communities to ensure that exposure of contaminants in prey, forage, and surface water does not have a negative impact on growth, survival, and reproduction. Aerial insectivorous mammals are ecologically important because they help to control the size of the invertebrate population that might otherwise damage populations of plant primary producers. They also are susceptible to soil or water constituents within the waste unit. Bats are chosen as the representative species of the aerial insectivorous mammal niche because they are exposed to constituents by their consumption of flying invertebrates, and they utilize aquatic habitats as a source of water. Bats provide a beneficial service by foraging on flying insects, many of which are pests. They also eat large numbers of moths and beetles that cause agricultural damage. Bats will opportunistically roost and forage in various habitats. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of top carnivorous mammal communities to ensure that exposure of contaminants in prey does not have a negative impact on growth, survival, and reproduction. Carnivorous mammals are ecologically important because they maintain ecosystem structure and function by feeding on primary consumers (herbivores), reducing the impacts of herbivory. The red fox is selected as the representative top carnivore because they represent a mammal with a relatively high contaminant biomagnification potential due to their largely carnivorous feeding habits. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of benthic invertebrate (sediment dwelling organism) communities from toxic effects of contaminants to maintain species diversity, biomass, and nutrient cycling (trophic structure). Identification of a specific receptor for this endpoint is not necessary. The benthic invertebrate community is ecologically important, serving as prey items for many other species as well as maintaining nutrient cycling in an aquatic system. Benthic organisms also are susceptible to constituents in sediment and are potentially exposed within the waste unit. The measurement endpoint is the measured concentration in sediment media compared to sediment toxicity threshold values. This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

- Protection of aquatic organism communities from the toxic effects of contaminants in abiotic media and food to maintain species diversity and ensure that ingestion of contaminants in fish and aquatic invertebrates do not have a negative impact on growth, survival, and reproduction. The aquatic community is ecologically important, serving as prey items for many species. Aquatic organisms are susceptible to constituents in surface water and are potentially exposed to contamination within the waste unit. The measurement endpoint is the measured concentration in surface water media compared to ambient water quality criteria (AWQC). This preliminary comparison is expressed as a HQ calculation based on the screening of OU data.

PROTOCOL

Constituents of Potential Ecological Concern

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of constituents of potential ecological concern (COPECs). The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

This protocol is considered the first step in the formal ecological risk data evaluation process, i.e., the screening-level effects evaluation. Typically, it is implemented after the exposure groups are identified and the data are appropriately processed in accordance with established protocols pertaining to data grouping and processing (see Step 1 below).

Ecological threshold levels are media- and receptor-specific values that can be used to evaluate (i.e., screen) soil, sediment, and surface water data from potentially contaminated sites. The thresholds are derived from several sources and are used to evaluate conservative (protective) thresholds such as No Observed Adverse Effect Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs). The ecological screening values (ESVs) are used in the initial screening level effects evaluation and are derived from NOAEL-based thresholds for soil and sediment, and chronic ambient water quality criteria (AWQC) for surface water. For constituents that exceed ESVs and background screening, refinement screening values (RSVs) are used for the refinement-level risk calculation (protocol ECO-4) using LOAEL-based thresholds. Derivation of the ESVs and RSVs is described in the *Sources of Ecological Screening Values Protocol* (ECO-1).

For soil, ESVs are based on the minimum value from the following:

- Region 4 Soil Screening Values for Hazardous Waste Sites, Screening Level, Table 3 (EPA 2018).
- Los Alamos National Laboratory Receptor-specific Ecological Screening Level (ESL), No Effect ESL (LANL 2017).

For sediment, ESVs are based on the minimum value from the following:

- Region 4 Sediment Screening Values for Hazardous Waste Sites, Screening Level, Table 2a (Non-Narcotic Modes of Action) and Table 2b (Narcotic Mode of Action (EPA 2018).
- Los Alamos National Laboratory Receptor-specific ESL, No Effect ESL (LANL 2017).

For sediment/soil, (wetland soils, floodplain sediment), the thresholds are based on the lowest of the soil or sediment values for each constituent.

For surface water, ESVs are based on the minimum value from the following:

- Region 4 Surface Water Screening Values for Hazardous Waste Sites, Chronic Freshwater screening values, Table 1a (EPA 2018).
- Los Alamos National Laboratory Receptor-specific ESL, No Effect ESL (LANL 2017).
- SCDHEC R.61.68 Water Classification and Standards Table for Protection of Freshwater Aquatic Life, Water Quality Numeric Criteria for the Protection of Aquatic Life and Human Health appendix, continuous concentration criterion (CCC) thresholds that represent the highest instream concentration of a toxicant or an effluent to which the organisms can be exposed to protect against chronic (long-term) effects. EPA derives chronic criteria from longer term (often greater than 28 days) tests that measure survival, growth, reproduction, and in some cases bioconcentration. ESVs should be adjusted for hardness- and pH- dependent analytes as described in the regulation.

Details

Figure 1 is a flowchart of the COPEC selection process described below. Table 1 is a sample COPEC soil screening table; sediment and surface water screening tables have the same format.

Step 1: Data Preparation

Data for each constituent should be sorted by medium as described in the *Development of Exposure Groups Protocol* (DG-1). Data should be processed in accordance with the *Unit-Source Data Processing Protocol* (DP-1), *Unit-Background Data Processing Protocol* (DP-2), if appropriate, and *Surrogates for Non-Detects Protocol* (DP-3). For any data which have qualifiers, determine if the qualified data should be retained. Do not eliminate data based on "J" qualifiers.

Calcium, magnesium, potassium and sodium are excluded from further evaluation because they are essential nutrients that are not considered toxic and do not have ecological threshold limits.

Step 2: ESV Comparison

Soil and Sediment

Compare the unit maximum detected concentration to the ESV concentration (No Effect ESL) for the surface interval (0 to 1 ft, soil and sediment) and subsurface interval (1 to 4 ft, soil only) and calculate a screening level HQ for each interval.

$$\text{Screening HQ} = \text{Maximum Detected Concentration} / \text{ESV}$$

Surface Water

Compare the unit maximum concentration to the ESV concentration (ambient water quality criteria chronic values or No Effect ESL) and calculate a screening level HQ.

Screening HQ = Maximum Detected Concentration / ESV

Retain the constituent for further analysis if its maximum value exceeds the appropriate ESV. The constituent is eliminated from further evaluation if its maximum value is less than the ESV.

Determine if the constituent is naturally occurring or anthropogenic. Naturally occurring constituents are the result of geologic source materials and geochemical processes that have not been influenced by human activity. Anthropogenic constituents are synthetic or natural substances that have been released to the environment as a result of human activities (e.g., atmospheric deposition of mercury, etc.). Anthropogenic constituents that exceed the ESV will be identified as COPECs (Step 4) and carried forward through a more detailed analysis of ecological risk. Naturally occurring constituents that exceed the ESV screen shall proceed to Step 3.

Step 3: Background Comparison

For naturally occurring inorganics and radionuclide constituents, compare the maximum concentration to two times the average background concentration from the approved SRS soil background dataset (WSRC 2006)[1] (or unit-specific background) for each exposure group. For soils and sediments, the unit maximum value from the 0 to 0.3 m (0 to1 ft) and 0.3 to 1.2 m (1 to 4 ft) depth intervals (soil only) are compared to two-times (2X) the average SRS background value (0 to 0.3 m [0 to 1 ft] interval) for a particular constituent.

For surface water media, or sediment, if appropriate, use the two times average background concentration from the site specific background dataset if available.

Retain the constituent for further analysis if its maximum value exceeds the background screening value. The constituent is eliminated from further evaluation if its maximum value is less than the background screening value.

Step 4: COPEC Identification

Constituents exceeding the ESV (HQ > 1), or with no ESV and exceeding the background screen, or with no ESV and no background data for comparison, are identified as COPECs and are carried forward to the refinement level step described in the *Ecological Constituents of Potential Concern Protocol* (ECO-4). Constituents that are not identified as COPECs are dropped from further evaluation.

[1] WSRC 2006. *Background Soils Statistical Summary Report for the Savannah River Site*, ERD-EN-2006-0223, Revision 1, Washington Savannah River Company, Savannah River Site, Appendix B-1.

This page is intentionally left blank.

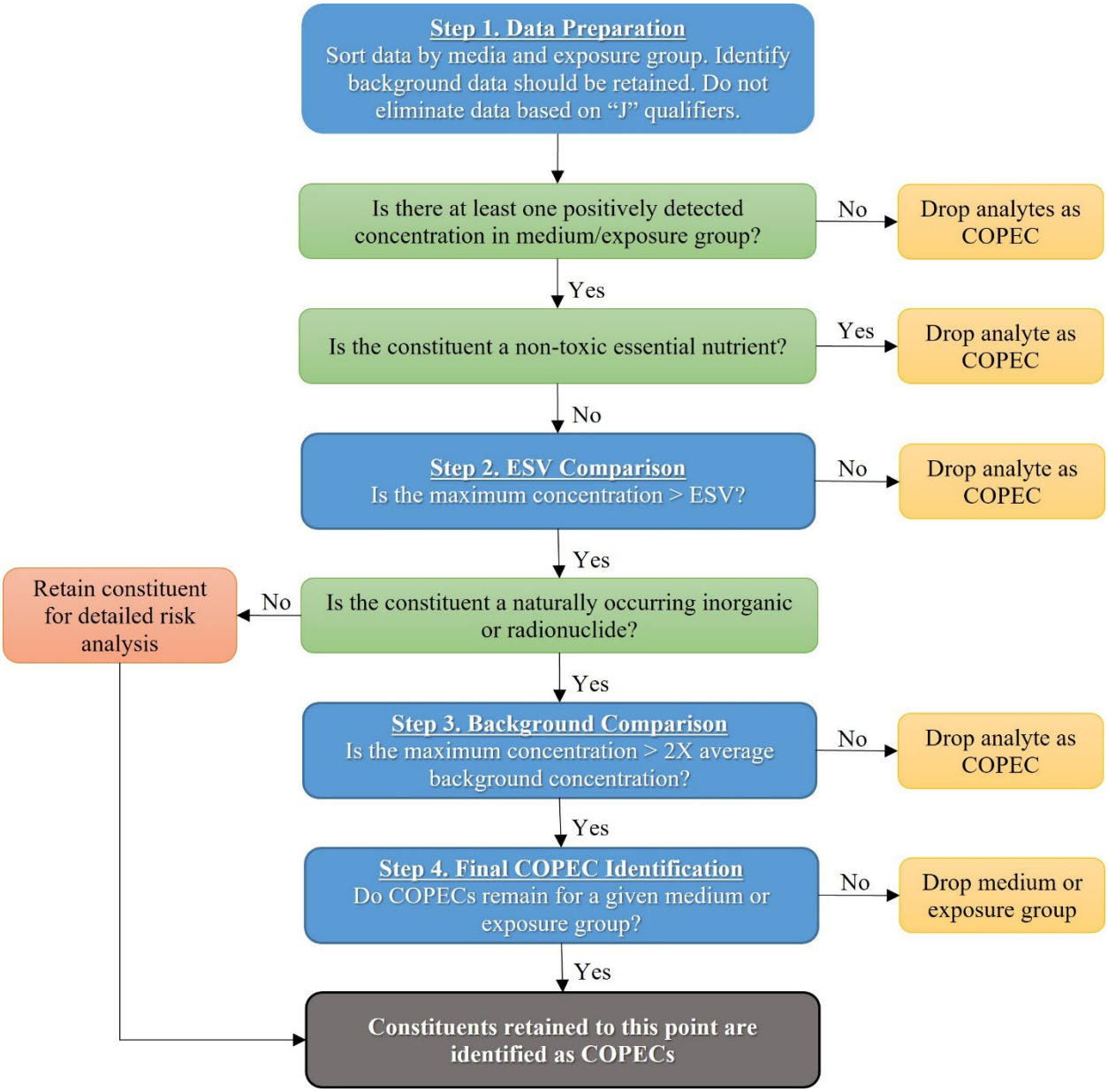


Figure 1. Flowchart of the COPEC Selection Process

Table 1. (Sample) COPEC Screening for Surface Soil (0 to 0.3 m [0 to 1 ft])

Analyte	Detected Maximum Concentration	Qualifier	ESV	ESV Source[1]	Screening Level HQ[2]	2X Average Background Concetration[3]	Exceeds 2X Average Background Concentration?[4]	COPEC?[5]
Inorganics *(mg/kg)*								
Constituent A	1.05E+04		7.61E+02	a	1.38E+01	1.30E+04	no	no
Constituent B	3.98E+00	J	3.90E-01	a	1.02E+01	2.60E+00	YES	**COPEC**
Constituent C	3.82E+01		6.37E+02	a	6.00E-02	4.58E+01	no	no
Constituent D	9.30E-01		1.54E+01	b	6.04E-02	NA	NA	no
Constituent E	5.92E+02		NA	Nutrient[6]	NA	4.88E+02	YES	no
Constituent F	4.32E+01		2.11E+02	a	2.05E-01	2.96E+01	YES	no
Constituent G	4.30E+00		3.10E+01	ab	1.39E-01	6.16E+00	no	no
Organics *(mg/kg)*								
Constituent H	7.23E+02		7.50E+01	a	9.64E+00	NA	NA	**COPEC**
Constituent I	1.35E-01	J	1.57E+02	a	8.60E-04	NA	NA	no
Constituent J	6.54E+01		9.11E+00	a	7.18E+00	NA	NA	**COPEC**
Constituent K	4.16E-02		7.00E+00	b	5.94E-03	NA	NA	no
Constituent L	3.36E-03	J	1.51E+00	a	2.23E-03	NA	NA	no
Pesticides/PCBs *(mg/kg)*								
Constituent M	4.89E+01		2.72E+00	a	1.80E+01	NA	NA	**COPEC**
Constituent N	1.22E-03		1.80E+00	b	6.78E-04	NA	NA	no
Radionuclides *(pCi/g)*								
Constituent O	1.35E+00		7.30E+01	b	1.85E-02	2.14E+00	no	no
Constituent P	8.47E-01	J	8.19E+00	b	1.03E-01	1.43E+00	no	no
Constituent Q	4.99E+02		2.99E+02	b	1.67E+00	1.06E+00	YES	**COPEC**
Constituent R	1.94E+01		1.50E+01	b	1.29E+00	8.02E-01	YES	**COPEC**
Constituent S	9.55E-01		6.20E+00	b	1.54E-01	1.53E+00	no	no
Constituent T	1.38E+00		4.40E+01	b	3.14E-02	2.94E+00	no	no
Constituent U	8.47E-01		2.00E+03	b	4.24E-04	1.43E+00	no	no

1 - ESV = ecological screening value; a = Table 3, EPA Region 4 Ecological Risk Assessment Supplemental Guidance March 2018 Update (2018)

1 - b = Los Alamos National Laboratory No Effect ESL for soil media (2017)

2 - Screening Level Hazard Quotient (HQ) = maximum detected concentration/ESV

3 - Background screening values obtained from *Background Soils Statistical Summary Report for the Savannah River Site (*WSRC 226), Table B-1 (0-1 ft interval).

4 - For screening purposes, maximum concentration of only the naturally-occurring (nonanthropogenic) constituents are compared to 2X average background concentration.

5 - Constituents are identified as COPECs if the maximum detected concentration exceeds the ecological screening value and the 2X average background concentration.

6 - Essential nutrients are not identified as COPECs, ESV not available.

PROTOCOL

Ecological Constituents of Potential Concern / Constituents of Concern

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of Ecological (ECO) Constituents of Potential Concern (COPCs) and Constituents of Concern (COCs). The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

This protocol is to be applied to constituents when a refinement-level hazard calculation is needed. Typically it is used after the *Constituents of Potential Ecological Concern Protocol* (ECO-4) has been implemented and constituents of potential ecological concern (COPECs) have been identified; however, it can be used on the entire list of detected analytes if the formal COPEC screening has not been performed.

Ecological threshold levels are media- and receptor-specific values that can be used to evaluate (i.e., screen) soil, sediment, and surface water data from potentially contaminated sites. The thresholds are derived from several sources and are used to evaluate conservative (protective) thresholds such as No Observed Adverse Effect Levels (NOAELs) and Lowest Observed Adverse Effect Levels (LOAELs). Refinement screening values (RSVs) are used for the refinement-level risk calculation. The RSVs are based on LOAEL thresholds appropriate for refinement of sediment, soil, and surface water media constituents. Derivation of the RSVs is described in the *Sources of Ecological Screening Values Protocol* (ECO-1).

For soil, RSVs are based on the minimum value from the following:

- Los Alamos National Laboratory Receptor-specific Ecological Screening Level (ESL), Low Effect ESL (LANL 2017).

For sediment, RSVs are based on the minimum value from the following:

- Region 4 Sediment Screening Values for Hazardous Waste Sites, Screening Level, Table 2a (Non-Narcotic Modes of Action) and Table 2b (Narcotic Mode of Action (EPA 2018).
- Los Alamos National Laboratory Receptor-specific ESL, Low Effect ESL (LANL 2017).

For sediment/soil, (wetland soils, floodplain sediment), the thresholds are based on the lowest of the soil or sediment values for each constituent.

For surface water, RSVs are based on the minimum value from the following:

- Region 4 Surface Water Screening Values for Hazardous Waste Sites, Chronic Freshwater screening values, Table 1a (EPA 2018).
- Los Alamos National Laboratory Receptor-specific ESL, Low Effect ESL (LANL 2017).
- SCDHEC R.61.68 Water Classification and Standards Table for Protection of Freshwater Aquatic Life, Water Quality Numeric Criteria for the Protection of Aquatic Life and Human Health appendix, continuous concentration criterion (CCC) thresholds that represent the highest instream concentration of a toxicant or an effluent to which the organisms can be exposed to protect against chronic (long-term) effects. EPA derives chronic criteria from longer term (often greater than 28 days) tests that measure survival, growth, reproduction, and in some cases bioconcentration. RSVs should be adjusted for hardness- and pH- dependent analytes as described in the regulation.

Details

The refinement evaluation uses RSVs. Because of the conservative approach of the initial screening level evaluation (i.e., ESV screening), some of the constituents identified for further evaluation may or may not pose a possible unacceptable risk to ecological receptors. The refinement screening process applies a more realistic and holistic approach to screening to further refine the list to those constituents that require further discussion and scrutiny. The method used to further refine ecological COPECs is based on the calculation of a refinement-level HQ by comparing the Exposure Point Concentration (EPC) to a LOAEL-based RSV. LOAEL-based RSVs are derived from Low Effect ESLs. The EPC is represented by the lower of the 95% UCL on the mean and maximum detected concentrations. Calculation of the HQ is illustrated in the equation below:

$$\text{Refinement HQ} = \text{EPC}/(\text{LOAEL-based RSV})$$

Table 1 is a sample COPC refinement-level screening table for soil media; sediment and surface water screening tables have the same format.

Soil and Sediment

For the constituents identified as COPECs, calculate a refinement level HQ using the EPC and RSV (LOAEL-based ESL).

Constituents with refinement levels HQ > 1 or with no RSV are identified as COPCs. Constituents that are not identified as COPCs are dropped from further evaluation.

Surface Water

For the constituents identified as COPECs, calculate a refinement level HQ using the EPC and RSV (chronic value for AWQC, LOAEL ESL for wildlife receptors).

Constituents with refinement levels HQ > 1 or with no RSV are identified as COPCs. Constituents that are not identified as COPCs are dropped from further evaluation.

Constituents retained to this point in the process are identified as ECO COPCs. A determination is made if site-specific ecological studies or other biological data may be needed to address uncertainty associated with using literature-based values only at this stage of the process and whether or not a remedial decision can be made from an ecological risk perspective. If deemed appropriate, the *Ecological Site-Specific Data/Studies Protocol (ECO-5)* provides information on the types of ecological studies or biological data (e.g., food chain modeling, toxicity testing, community assessments, bioaccumulation studies) that are typically used to address significant uncertainty.

If additional studies are not warranted, then the COPCs are identified as constituents of concern (COCs) and are carried forward to an uncertainty discussion (i.e., *Constituents of Concern Refinement Process Protocol* [COC-1]).

Table 1. (Sample) Refinement-Level Evaluation for Surface Soil (0 to 0.3 m [0 to 1 ft])

Analyte[1]	Exposure Point Concentration[2]	RSV[3]	RSV Source[4]	Refinement Level HQ[5]	HQ Exceeds RSV (HQ>1)?	COPC?[6]
Inorganics (mg/kg)						
Constituent A	8.48E-01	2.5E+01	b	3.39E-02	no	no
Constituent B	1.96E-01	3.6E+00	b	5.44E-02	no	no
Constituent C	2.48E+01	7.3E+01	b	3.40E-01	no	no
Constituent D	1.61E+04	--	--	--	--	YES
Constituent E	3.78E+00	5.0E-01	b	7.56E+00	YES	YES
Constituent F	4.93E+01	9.5E+00	b	5.19E+00	YES	YES
Constituent G	1.17E+02	4.7E+02	b	2.49E-01	no	no
Organics (mg/kg)						
Constituent H	1.45E-02	1.1E-01	b	1.32E-01	no	no
Constituent I	2.29E-01	9.4E-01	b	2.44E-01	no	no
Pesticides/PCBs (mg/kg)						
Constituent J	1.98E-00	4.1E-01	b	4.83E+00	YES	YES
Constituent K	1.22E-02	8.8E+00	b	1.39E-03	no	no
Radionuclides (pCi/g)						
Constituent L	1.95E+00	1.2E+00	b	1.6E+00	YES	YES
Constituent M	5.61E-01	--	b	--	--	YES

1 - Analytes identified as COPECs.
2 - EPC = reasonable maximum exposure (RME) exposure point concentration (EPC) is the lesser of the maximum detected concentration and the 95% upper confidence limit (UCL) on the mean concentration.
3 - RSV from Attachment X.
4 - a = Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance March 2018 Update (2018)
b = Los Alamos National Laboratory Low Effect ESL for Soil Media (2017)
5 - Refinement Level Hazard Quotient (HQ) = EPC / RSV
6 - COPC = constituent of potential concern. Analyte identified as a COPC if the refinement level HQ>1

PROTOCOL

Ecological Site-Specific Data/Studies

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides information on the types of studies that are typically used to address uncertainty following implementation of the *Ecological Constituents of Potential Concern/Constituents of Concern Protocol* (ECO-4). This protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

Following identification of ecological (ECO) constituents of potential concern (COPCs), a determination is made if site-specific ecological studies or other biological data may be needed to address critical uncertainties associated with using literature-based values only at this stage of the ecological risk assessment (ERA) process, and whether or not a remedial decision can be made from an ecological risk perspective. As part of the operable unit scoping process, the project Core Team will consider any recommendation from the subject matter experts and determine whether ecological site-specific data/studies and/or additional investigations are warranted. If deemed appropriate, a site-specific study plan is designed to ensure that adequate data are collected to support the ERA. This study plan is reviewed and approved by the regulatory agencies before data collection begins. There are a limited number of fundamental approaches for conducting site-specific investigations on ecological impacts of hazardous substances. Further soil/sediment/surface water sampling, tissue residue studies, toxicity testing, and population or community evaluations are examples of the most commonly used methodologies but are not exclusive of other site-specific approaches to address possible site-specific data gaps.

Food-chain Models and Toxicity Reference Values

Measurement endpoints involving prediction of the risk to wildlife receptors typically rely on food-chain models of the daily intake of chemicals in dietary items consumed by wildlife for estimation of a daily dose. When planning to use food-chain models in the ERA, all of the assumptions that will be made for the food chain model calculations will be identified. These assumptions include items such as the intake rates and body weights of model receptors and the toxicity reference values that will be used to characterize the risk. It is recommended that the Wildlife Exposure Factors Handbook (https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=2799) be consulted for developing input parameters for the model. It is also recommended that the EPA Region 4 risk assessment website be consulted for exposure assumptions and toxicity reference values (TRVs). This website (https://www.epa.gov/risk/ecological-risk-models-and-tools) has values and tools for developing screening values that can be used in most food chain models. If studies other than the

recommended values are used or there are no recommended values on the EPA website, then a justification should be provided that contains a review of the pertinent toxicity information for the chemical. This justification should include 1) a summary of potential effects from chemicals when present in aquatic and terrestrial environments, and 2) a summary of the No Observed Adverse Effects Level (NOAEL) and Lowest Observed Adverse Effects Level (LOAEL) chosen for each chemical as reported in the literature. These data should also present the literature citation and a brief description of the study conducted so that an evaluation can be made as to how applicable the study results are to hazardous waste sites. The description should include the setting of the study (laboratory or field), length of exposure, type of exposure, effects measured, the date of the study, and the results of the study. If receptors other than the ones provided on the EPA table of recommended exposure assumptions are used, the baseline problem formulation report should include a section describing the characteristics of the receptors and how the parameters were obtained. Alternate TRVs may be used; however the preference is to use EPA Region 4 values when they are available. If the EPA Region 4 values are used, then the original citations and the information requested above is not necessary to include.

Toxicity Tests

Toxicity testing is commonly employed to determine potential risk via direct contact with contaminated soil, sediment, or surface water. Toxicity testing can be inconclusive and must be carefully designed to ensure that the proper test species are used for the environmental medium being evaluated, and environmental conditions are appropriate for the intended application. For example, a benthic macroinvertebrate such as *Hyalella* should be used as a test subject in freshwater sediment toxicity tests rather than free-swimming organisms such as *Ceriodaphnia*.

Community Assessments

Community or population evaluations involve floral or faunal field surveys and the computation of indices such as species diversity and richness that can be used as measurement endpoints. These types of studies should be used with caution in an ERA because the various diversity and richness indices were not developed to measure ecological impacts of hazardous materials in the environment. Natural variability in population and community structure (e.g., spatial and seasonal effects), lack of sensitivity of some species to certain chemicals and impacts to population/community structure from non-chemical stressors make the interpretation of these studies difficult in the context of distinguishing between these effects and those from hazardous substances. Therefore, comparison of biological community metrics between the site and reference areas should be used with caution and may not be a robust line of evidence with a high degree of confidence since a correlation does not imply causation. When using community metrics in an ERA, the experimental design and statistical analysis methods should be robust enough to evaluate whether conclusions based on community surveys can be supported. In addition, presentation of survey results should also be adequately documented and accompanied by a detailed uncertainty discussion.

Other Considerations

If there are multiple habitats at the site the Study Design should discuss the data groupings and the boundaries of the habitat areas. If there are bioaccumulative chemicals among the COPCs, the summary of available data should include any biological tissue data available for estimating site-specific bioaccumulation if these data are identified as critical data needs. The pairing of tissue data with abiotic data for estimation of bioaccumulation factors (BAFs) can also be discussed. For complex sites, the manner in which the BAFs are derived from site-specific tissue data collection prior to the initiation of the risk assessment should also be presented.

A summary of the results of site-specific studies should be presented in a detailed uncertainty evaluation as outlined in the *Constituents of Concern Refinement Process Protocol* (COC-1).

This page is intentionally left blank.

PROTOCOL

Ecological Preliminary Remedial Goals

Introduction

This protocol was developed to support the Savannah River Site environmental remediation program. It provides instructions for the identification of ecological (ECO) preliminary remedial goals (PRGs) to provide a range of risk-based cleanup levels for remedial decision making. The protocol is based on the latest available USEPA guidance and agreements from the representatives of the USEPA, SCDHEC, and USDOE.

This protocol applies to the ECO refined constituents of concern (RCOCs) that are identified after performing an uncertainty analysis per the *Constituents of Concern Refinement Process Protocol* (COC-1). This protocol describes the process for calculating ECO PRGs using literature-based values; implementation of the *Ecological Site-Specific Data/Studies Protocol* (ECO-5) allows for refinement of inputs/assumptions to standard threshold levels.

Details

For receptors that are considered sedentary and/or do not have a published home range (i.e., plants, soil invertebrates, sediment dwelling biota, aquatic organisms):

PRG = RSV (refinement screening value)

As a protective assumption appropriate for ecological risk screening, the area use factor (AUF) is set to 1 when calculating the HQ, making the conservative assumption that the animal receives all of its exposure from the contaminated site. This approach may overestimate risks to receptors whose home ranges are larger than the area of contamination being evaluated. To account for this overestimation of risk, the HQ can be modified by applying a population area use factor (PAUF), which uses the estimated area occupied by the population of a receptor species to assess the likelihood of any individual within the assessment population encountering the contaminated area. The PAUF is calculated based on the ratio of the operable unit (OU) area to the known home range of the receptor to reflect the receptor's utilization of an area that extends beyond the contaminated site.

Area of OU/ PAUF = OU specific PAUF

PRG = RSV / PAUF

Note that PRGs may also be calculated using the receptor-specific AUF as recommended by the project Core Team.

Table 1. Example Ecological PRG Calculation

Assume Operable Unit = 0.1605 hectares

Receptor	AUF (ha)[1]	PAUF (ha)[2]	Operable Unit Specific AUF[3]	Operable Unit Specific PAUF[4]
American kestrel	106	4240	1.51E-03	3.79E-05
American robin	0.42	16.8	3.82E-01	9.55E-03
Deer Mouse	0.077	3	2.08E+00	5.35E-02
Desert cottontail	3.1	124	5.18E-02	1.29E-03
Montane shrew	0.39	15.6	4.12E-01	1.03E-02
Red fox	1038	41520	1.55E-04	3.87E-06
Violet-green swallow	0.68	27.2	2.36E-01	5.90E-03
Occult little brown myotis bat	100	4000	1.61E-03	4.01E-05

1 – AUF = Area Use Factor; Home range taken from Table 3.3-1 of LANL 2015 Screening Level Ecological Risk Assessment Methods, Revision 4
2 – PAUF = Population Area Use Factor; Population area taken from Table 3.3-1 of LANL 2015 Screening Level Ecological Risk Assessment Methods, Revision 4
3 – Operable Unit-Specific Area Use Factor (AUF) = Operable Unit area (ha) / AUF (ha)
4 – Operable Unit-Specific Population Area Use Factor (PAUF) = Operable Unit area (ha) / PAUF (ha)

Receptor	RSV[1] (mg/kg)	Operable Unit Specific PAUF	PRG[2] (mg/kg)
American kestrel	150	3.79E-05	3.96E+06
American robin[3]	*23*	*9.55E-03*	*2.41E+03*
Deer Mouse	230	5.35E-02	4.30E+03
Desert cottontail	600	1.29E-03	4.65E+05
Montane shrew	170	1.03E-02	1.65E+04
Red fox	7000	3.87E-06	1.81E+09
Violet-green swallow	52	5.90E-03	8.81E+03
Occult little brown myotis bat	220	4.01E-05	5.49E+06

1 - RSV = LOAEL-based refinement screening value for Constituent A
2 - PRG = RSV/PAUF
3 - Most restrictive (lowest, most conservative) PRG from the values shown in italics

Media	Receptor	Constituent	PRG Range[1] (mg/kg)	MR PRG[2]	HQ Basis[3]
Soil	American robin	Constituent A	2.41E+03 - 1.81E+09	**2.4E1+03**	HQ =1

1 - PRG range of concentrations for all receptors for Constituent A
2 - Most restrictive PRG (lowest, most conservative)
3 - HQ Basis = 1 after consideration of Operable Unit specific PAUF

PROTOCOL

Constituents of Concern (COC) Refinement Process

Introduction

The contaminant migration technical analyses, the human health assessment, the ecological assessment, the Applicable or Relevant and Appropriate Requirements (ARAR) screening, and the principal source material screening that are used in the remedial investigation reports are performed using processes agreed upon by the three parties (i.e., USDOE, USEPA, and SCDHEC) to the Federal Facility Agreement (FFA). These assessments and analyses are used to identify contaminants which may require remedial action due to risk, regulatory, or source control concerns. In some cases, however, remedial action may not be necessary or appropriate for all of these identified contaminants. Therefore, a secondary selection process would be beneficial to identify the constituents of concern (COCs) which should be carried forward for remedial alternative screening. This selection process should identify those COCs which have a reasonable likelihood of being released, are consistent with the conceptual site model, and pose an adverse hazard or risk to human health or the environment. COCs that are carried forward following the refinement process are designated as refined COCs (RCOCs). This protocol describes the refinement process.

The recommendation of whether or not a COC should be carried forward for further remedial evaluation must be based on a prescribed analysis of each COC. It is unlikely that any COC will be eliminated based on a single uncertainty category. Instead, all of the applicable uncertainty factors are compared and the cumulative effect of the factors are used to determine whether a COC should be eliminated from further consideration. It should be noted that the presence of high uncertainty in a category does not in itself lead to non-selection. In fact, the presence of a high degree of uncertainty regarding concentration or distribution could lead to inclusion as a RCOC. This protocol provides a listing and discussion of a number of uncertainty factors which may be important for determining whether a constituent should or should not be carried forward for further remedial consideration.

Refinement Process Criteria

The uncertainty analysis will be performed for the following types of COCs: ARAR COCs, Contaminant Migration COCs (CM COCs), Human Health COCs (HH COCs), Ecological COCs (ECO COCs), and Principal Threat Source Material (PTSM) COCs.

For each individual COC, prepare an interpretive discussion of the applicable uncertainty factors and provide a recommendation to indicate whether the constituent should or should not be carried forward for further remedial evaluation.

Major Categories of Uncertainty

The following categories of uncertainty relating to the COC selection process have been developed and defined for use at the Savannah River Site (SRS). For each COC, as applicable, individual uncertainty factors are grouped and discussed under four major uncertainty categories to include unit related, data quality, risk assessment, and contaminant migration uncertainties. These major uncertainty categories will be used to provide a complete summary discussion for each COC. Individual uncertainty factors are briefly discussed below:

- **Unit Related Uncertainty**
  - Nature and Extent of Contamination
  - Consistency with History of Use
  - Presence in Background
- **Data Quality Uncertainty**
  - Analytical Data Quality
  - Physical Characteristics
- **Risk Assessment Uncertainty**
  - Toxicity Data
  - Radioactive Decay
  - Consideration of Area Use Factors
- **Contaminant Migration Uncertainty**
  - Presence in Groundwater

Description of Uncertainty Factors

- **Nature and Extent of Contamination**

  Unit-related contamination should be evaluated based on its nature and extent (distribution). This analysis should be primarily based on the relative abundance of "detects" in the total number of samples and the presence or absence of discernible patterns of contamination in the impacted media and source. This evaluation should also consider the number of data points and the quality of the dataset in question, as appropriate. The evaluation should determine if the distribution of the data indicates the constituent is ubiquitous for the unit or from a discernible source. Planar maps and cross-sections of the distribution of analytes may be used to illustrate the results. Statistical analysis may also be used.

- **Consistency with History of Use**

  SRS has compiled a significant amount of historical information on the use of the site, including past disposal inventory reports. Unit history is just one of several potential lines of evidence that are available in the COC refinement process. Although the amount of historical information will differ between waste units, historical consistency in the contaminant types and concentrations found at the unit may be important considerations in

the overall uncertainty evaluation. Based on this information, a determination could be made as to whether the history of use is consistent with the concentration and type of contaminant found at the unit.

- **Presence in Background**

  SRS has extensive information based on USEPA and SRS published documents on the concentration of contaminants in non-unit-related media at the SRS and surrounding region. An evaluation should be made as to whether the contaminant is present at a concentration significantly different from unit background and/or SRS background. Alternate graphical and/or statistical methods for comparison may be used to support this evaluation. The USEPA and SCDHEC will be consulted with regard to the use of alternate methods for comparison of background data sets.

- **Analytical Data Quality**

  The Data Usability Report provides the analytical data and the associated analytical qualifiers. In some cases, constituents may have data quality flags (result and analytical qualifiers) indicating the concentration was estimated and providing the nature of the analytical issue. An evaluation must be made whether the data quality is sufficient to serve as the basis for remedial decisions. If there is uncertainty concerning the concentration of a COC, then additional samples should be collected to confirm the concentration. In addition, if the data set is not of sufficient quality to serve as a basis for a remedial decision, then no COCs should be removed and additional data should be collected. A COC may be removed from further remedial evaluation if the data is of adequate quality, and there is supporting information that infrequent detections are not due to a source release. After examining the entire data set, a recommendation can be made as to whether the COC should or should not be considered for further remedial evaluation.

- **Physical Characteristics**

  If an analyte seems out of place within a given media, then evaluate the probability that it actually exists using its physical characteristics. For example, if a radionuclide COC is naturally occurring in the environment and associated daughter products from the same decay series are detected at similar concentrations (secular equilibrium), then this would increase the uncertainty that the parent constituent is unit related. In addition, a short-lived radionuclide detected in soil long after it should have decayed away would be viewed with uncertainty since the "detection" may be a false positive Additional characterization may be needed to determine if the constituent is actually present in the environment. In the absence of unit-related activities, the physical characteristics of a COC should be considered to determine if the constituent should undergo further remedial evaluation, or if additional characterization is needed to better manage the uncertainty.

- **Toxicity Data**

  COCs which were determined based on the use of surrogate or provisional toxicity, or where toxicity reference values for a given constituent are highly variable, should be closely examined. The specific details of the status of the provisional toxicity information

and the chemical/physical relationships between the COC and the surrogate should be closely examined before considering the COC for further remedial evaluation.

- **Radioactive Decay**

  Many of the assessments performed in support of the RFI/RI/BRA assume that the present day concentration of contaminants will persist throughout the period of interest. This is not an accurate assumption for many radionuclide constituents. As part of the uncertainty analysis, radiological analytes should be mathematically decayed over the time period of interest. For example, if 30 years is the period of interest, then the radionuclide should be decayed over that time and the final activity reported. For contaminant migration, the radionuclide should be decayed for the travel time to the aquifer. Radionuclide decay and the decayed activity for the period of interest should be evaluated and used in the determination of whether a COC should be carried forward for further remedial evaluation.

- **Consideration of Area Use Factors (ecological risk assessment only)**

  As a protective assumption appropriate for ecological risk screening, the area use factor (AUF) is set to 1 when calculating the hazard quotient (HQ), making the conservative assumption that the animal receives all of its exposure from the contaminated site. This approach may overestimate risks to receptors whose home ranges are larger than the area of contamination being evaluated. To account for this overestimation of risk, the HQ can be modified by applying a population area use factor (PAUF), which uses the estimated area occupied by the population of a receptor species to assess the likelihood of any individual within the assessment population encountering the contaminated area. The PAUF is calculated based on the ratio of the subunit size to the known home range of the receptor to reflect the fact that receptors utilize an area beyond just the contaminated site.

  In addition, average unit concentrations are given more significance than maximum concentrations since the wildlife receptors under consideration are not sedentary and their exposure is averaged over a larger area than that encountered at a single sampling location. The exception to the assumption of non-sedentary behavior may include soil invertebrates (i.e., earthworm), benthic organisms (for sediment media), and aquatic organisms (surface water). However, this is offset by the fact that the soil invertebrate, benthic organism, and aquatic organism endpoints are established at the community level, and effects caused by a maximum concentration at a single location would not cause community-level impacts.

  PAUF-adjusted HQs based on mean concentrations should be evaluated and used in the determination of whether an ecological COC should be carried forward for further remedial evaluation.

- **Presence in Groundwater (contaminant migration consideration only)**

  This category is used to evaluate whether groundwater sampling results corroborate the contaminant migration modeling predictions. For example, if the model predicts that a contaminant should be present in groundwater 10 years after it was released to the soils and the empirical groundwater data indicates it is not present although disposal took place 40 years ago, retaining the COC for further remedial evaluation is viewed with greater

uncertainty. The presence or absence of the contaminant in actual groundwater sampling results should be evaluated and used in the determination of whether a COC should be carried forward for further remedial evaluation.

Implementation of this protocol results in the identification of RCOCs that are recommended for further remedial evaluation. The decision to carry a COC forward for further remedial evaluation will be evaluated, discussed, and decided upon by the Core Team using all available information. Remedial Action Objectives (RAOs) and Preliminary Remedial Goals (PRGs) will be developed for these RCOCs.

This page is intentionally left blank.

PROTOCOL

Groundwater Modeling in the Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation and Liability Act Process

Introduction

This protocol has been developed to support the Savannah River Site environmental restoration program. This protocol is intended to explain the objectives and provide guidance for groundwater modeling in the Remedial Facility Investigation (RFI)/Remedial Investigation (RI) Work Plan, RFI/RI Baseline Risk Assessment (BRA), Corrective Measures Study (CMS)/Feasibility Study (FS) and post-Record of Decision (ROD) stages of the Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process.

Details

Work Plan Stage

The need for groundwater modeling should be evaluated early in the RCRA/CERCLA process beginning with the Work Plan stage. Evaluating potential modeling needs at the Work Plan stage will allow for the collection of the necessary data and will reduce the uncertainty in model predictions. Therefore, the quality and quantity of these data must be sufficient for development of a hydrogeological conceptual model (HCM) that responds in a manner that is consistent with the physical and geochemical systems, and if warranted, allows for the construction of a groundwater flow and fate and transport model. Protocol GW-2, *Developing the Hydrogeological Conceptual Model*, should be reviewed to determine the type of data needed. A review of data from both the subject operable unit (OU) and nearby OUs or monitoring wells may be sufficient in meeting the data needs and should be reviewed for applicability.

Remedial Facility Investigation/Remedial Investigation/Baseline Risk Assessment Stage

As discussed in *Contaminant Migration Vadose Zone Contaminant Migration Multi-Layered Model* (CM-1), groundwater modeling is typically required as part of the RFI/RI/BRA stage if groundwater contamination in excess of applicable standards (e.g., Maximum Contaminant Levels [MCLs]) has been identified or if future groundwater contamination is predicted by a vadose zone transport model. The purpose of performing modeling in the RFI/RI/BRA stage of an OU is primarily to predict the future plume configuration under base case (No Action) conditions. This will help determine future potential impacts to deeper aquifers and surface water, allow for the development of groundwater remediation alternatives, and allow for the assessment of the current monitoring well network for adequacy. Groundwater modeling is typically required only for the contaminant migration refined constituents of concern (CM RCOCs); however, modeling of other

constituents may be included on the basis of parent/daughter relationships with the CM RCOCs, potential future threat to groundwater, etc. Alternatively, the CM RCOCs that exhibit the most significant MCL exceedances and plume extent may proxy for other CM RCOCs with similar fate and transport characteristics. The steps described in *Developing the Hydrogeological Conceptual Model* (GW-2) and *Groundwater Model Selection, Design, and Application* (GW-3) are followed to develop the HCM, select the groundwater model needs, design the model, apply the model, and document the modeling effort.

Corrective Measures Study/Feasibility Study Stage

In the CMS/FS stage, the groundwater model may be revised to include new data (e.g., contaminant concentrations, lithology, partition coefficients, etc.) that has been collected since development of the initial model that may aid in reducing the uncertainty in model predictions. The primary purpose of CMS/FS stage modeling is to evaluate the effectiveness of proposed remedial alternatives in meeting remedial action objectives or cleanup levels and supporting a comparative analysis of the alternatives. To initiate this process, a remedial alternatives conceptual model (RACM) is developed, as discussed in *Developing the Hydrogeological Conceptual Model* (GW-2). The RACM consists of a short summary and description of how each remedial alternative being considered in the CMS/FS will be modeled. The RACM will also include justification for any groupings of alternatives in the modeling. The modeling of the proposed remedial alternatives will be performed in a manner similar to the base case modeling conducted in the RFI/RI/BRA stage with incorporation of the RACM assumptions. In addition to alternative evaluation and comparison, modeling results can identify changes in plume dynamics (e.g., accelerating/retarding contaminant transport, contamination of other areas, etc.) and predict aquifer restoration time. The results of the modeling will be presented at the FS scoping meeting.

Uncertainty analyses are performed to assess the impacts of parameter, boundary condition, and/or model input uncertainty on model predictions of interest and is performed in accordance with *Sensitivity and Uncertainty Analysis for Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act Groundwater Modeling* (GW-4) and presented in the CMS/FS. The range of parameter uncertainty to be evaluated, likely parameter correlations (if any), uncertainty analysis method, and values to be predicted (e.g., concentrations at observation points at selected times) will be specified in the RACM for each remedial alternative.

The uncertainty will be studied for the base case and for each remedial alternative under consideration. The results should be summarized and compared by studying calibration residuals and statistics in tabular and graphical forms. Also, the predicted values for each scenario will be summarized and compared for selected observation points within the model domain.

A stand-alone document that describes the modeling performed for the remedial alternatives will be prepared with the results being incorporated and evaluated in the CMS/FS.

Post-Record of Decision Stage

Groundwater modeling may be required after the remedy has been implemented. This might be necessary if monitoring results collected to evaluate the effectiveness of the remedy indicate that cleanup levels are not being achieved - for example, if boundary compliance wells exceed MCLs, surface water is unexpectedly impacted, or the time frame to reach cleanup levels is significantly longer than earlier model predictions. Modeling might also be required if the assumptions regarding the efficiency of the treatment have been demonstrated to be incorrect, or if the groundwater flow characteristics have significantly changed (e.g., extraction wells that were removing water from the system are shut down).

Typically a groundwater model was developed to support the selection of the remedy. The HCM and/or RACM developed for that model would be reviewed to determine what assumptions may need to be modified based on current conditions. Both hydrogeologic and geochemical assumptions should be reviewed. Often, the current post-remedy contaminant plume can be compared to an earlier simulated result to inform the assumptions that might need to be revisited. An updated fate and transport model with the selected remedy may be sufficient, or additional treatment alternatives may need to be considered.

The results of the model would typically be presented in a stand-alone document detailing the modeling process, changes to the HCM/RACM, and results. The output from this post remedy modeling would be used to support decision making on any remedy changes that might be required.

This page is intentionally left blank.

PROTOCOL

Developing the Hydrogeological Conceptual Model

Introduction

This protocol has been developed to support the Savannah River Site environmental restoration program. This protocol is intended to provide guidance for the development of hydrogeological conceptual models (HCMs) supporting groundwater flow and transport (F&T) modeling in the Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation and Liability Act process using data that is valid and representative of the model domain.

Details

The first step in the groundwater modeling process is formulation of an HCM based on existing data. The HCM is a qualitative representation, typically illustrated with a simple diagram, that defines the hydrostratigraphic units of interest, potential source(s), contaminant(s), migration pathways, and all system boundaries for the assessment of flow system behavior. The HCM representation involves a comprehensive evaluation of existing data to develop spatial distributions of material properties for model input. The HCM describes the basis for model construction based on analysis of available data and is a critical step in constructing a groundwater F&T model. Given the imperfect knowledge of the flow system, refinement of the HCM should be expected during additional data collection(s) and the modeling process.

Once an HCM is defined, it is refined through analytical/numerical model development. This is accomplished by adjusting model parameters (i.e., model calibration). The goal of calibration is to minimize the differences between simulated and observed values that serve as calibration targets. Hypotheses regarding flow system behavior and contaminant transport are evaluated, resulting in an updated HCM and refinement of the conceptual understanding of the groundwater flow system and/or the contaminant migration within the model domain.

In order to construct an HCM that is representative of a physical system, it is essential to evaluate the data available. A groundwater F&T model is the combination of field data, parameters, conditions within established boundaries as well as identifying any source(s) to groundwater, potential contaminants of concern, and primary flow pathways that represent the groundwater F&T system. The use of valid, representative data is paramount to creation of a site-specific model that is capable of producing meaningful results. The HCM should be as simple as possible yet retain enough complexity to adequately reproduce system behavior.

Examples of data used to develop an HCM are:

Physical Framework

1. Geologic/lithologic map and cross sections showing the horizontal and vertical extent and boundaries of the system. Maps and cross sections may be scaled as appropriate for specific modeling tasks to aid in viewing and interpretation.
2. Stratigraphic descriptions of geologic units.
3. Topographic map, preferably a detailed Digital Elevation Model, showing surface water bodies and divides.
4. Contour maps showing the elevation of the base of the aquifers and confining beds.
5. Isopach maps showing the thickness of the aquifers and confining beds.
6. Maps showing the extent and depth of surface water bodies.
7. Maps showing location of infrastructure (i.e., buildings, roads, parking lots, discharge points, etc.).
8. Maps and tables illustrating the well network, and tables including screen depths and intervals.

Hydrogeologic Framework

1. Water table and potentiometric maps for all aquifers.
2. Hydrographs of groundwater head and surface water levels.
3. Surface water flow measurements.
4. Maps and cross sections showing the hydraulic conductivity and/or transmissivity distribution of aquifers and confining units.
5. Spatial and temporal distributions of rates of evapotranspiration, groundwater recharge, surface water-groundwater interaction, pumping, and natural groundwater discharge.
6. Identification of water usage and rates.
7. Meteorological data.

Contaminant Transport Framework

1. Identification of the contaminant source(s). Data needs for contaminant source(s) include, but are not limited to, source dimensions and location, source depth, and concentrations of contaminant(s) of concern.
2. Identification of key contaminants of concern. It is also important to identify break-down products or surrogates that could be of interest.
3. Identification of geochemical data needed for contaminants of concern (e.g., Kd's, f_{oc}, half-lives, retardation factors, etc.)
4. Identification of anthropogenic sources, background levels of key contaminants if applicable, or other sources unrelated to the source under investigation.

5. Initial contaminant plume extents and starting concentrations (e.g., plume maps, concentration cross-sections, etc.).
6. Contaminant transport interactions and migration pathways.

All data should undergo a critical review to ensure only valid and representative data is used in the HCM. All questionable or unrepresentative data should be discarded from the dataset with valid reasoning. Once the data has been evaluated and deemed acceptable for use in modeling of the model domain, the HCM may be developed.

There are five steps in developing an HCM:

1. Define the hydrostratigraphic units and model boundaries.
2. Define initial conditions.
3. Prepare a water budget.
4. Define the flow system.
5. Conceptualize contaminant transport inputs for HCM.

Substep A – Define the Hydrostratigraphic Units and Model Boundaries

Geologic information such as geologic maps and cross sections, well logs and core descriptions are combined with hydrogeologic data to define hydrostratigraphic units. Hydrostratigraphic units comprise geologic units of similar hydrogeologic properties. These properties may be defined through use of geophysical logs, hydraulic response test data (e.g., well injection/extraction tests or slug tests) or via geotechnical evaluations. In some cases, geologic facies can be used to define hydrostratigraphic units. In thick sequences of interbedded sand and clay, model layers may be defined using regional head data to determine hydraulic connectivity and/or identify units of similar hydrogeologic properties. Site-specific information on stratigraphy and hydraulic conductivity is required to define hydrostratigraphic units on a local scale.

Numerical models require boundary conditions, such that the head or flux must be specified at the borders of the model. Boundary conditions are mathematical statements specifying the dependent variable (flux) at the boundaries of the problem domain. Types of hydrogeologic boundaries are physical boundaries, hydraulic boundaries, and hydrogeologic boundaries. Physical boundaries are formed by the presence of an impermeable body of rock or a large body of surface water. Hydraulic boundaries include groundwater divides and streamlines.

The following types of mathematical conditions represent hydrogeologic boundaries, with descriptions and examples of the hydrogeologic boundaries presented in the following table (American Society for Testing and Materials [ASTM] D5609):

Type of Modeled Boundary	Sub-Type of Modeled Boundary	Description	Example
Specified Head, or Dirichlet	General Specified-Head Boundary	Head can be specified as a function of position and time.	Aquifer exposed along the bottom of a stream whose stage is independent of groundwater seepage. Heads along the stream bed are specified according to circumstances external to the groundwater flow system and maintain specified values throughout the problem solution.
Specified Head, or Dirichlet	Constant-Head Boundary	The aquifer system coincides with a surface of unchanging head through time.	Aquifer bordered by a lake where the surface water stage is constant over all points of the boundary in time or position.
Specified Flux, or Neumann	No Flow or Streamline Boundary	The flux across the boundary surface can be specified as a function of position and time (according to circumstances external to the groundwater flow system). The specified flux values are maintained throughout the problem solution.	Impermeable boundary (e.g., if the hydraulic conductivity of adjacent materials differs by orders of magnitude). Groundwater divide (however, divides may be subject to change with changing conditions and may produce invalid results).
Head Dependent Flux, or Cauchy	None	Flux across a part of the boundary surface changes in response to changes in head within the aquifer adjacent to the boundary. A practical limit exists beyond which changes in head cease to cause a change in flux.	The upper surface of an aquifer overlain by a confining bed that is in turn overlain by a body of surface water.
Free-Surface	None	A moveable boundary where the head is equal to the elevation of the boundary (no pressure head).	Water table (varies over time)
Seepage-Face	None	A boundary between the saturated flow field and the atmosphere along which groundwater discharges, either by evaporation or movement “downhill” along the land surface in response to gravity.	Seep line (typically insignificant for large or regional models)

The steps in boundary definition include (ASTM D5609):

1. Identification of the physical boundaries of the flow system – Identify as closely as possible the physical boundaries of the flow system. The 3-D bounding surfaces must be defined (even for 2-D models). Even if the boundaries are far from the area of interest, it is important to understand the location and hydraulic conditions on the flow system boundaries.

2. Boundary characterization – For each identified boundary, determine the hydraulic characteristics of the boundary, appropriate simplifying assumptions, and the most appropriate way to represent the boundary mathematically (i.e., specified head, specified flux, head-dependent flux, free surface, or seepage face boundary).

Substep B – Define Initial Conditions

Accurate definition of initial hydrologic conditions is an essential part of conceptualizing and modeling groundwater systems. Initial hydrologic conditions for a flow system are represented by the head distribution of the flow system at a specified time that is considered the reference head at zero time, or initial time. Initial conditions will be determined in accordance with the ASTM *Standard Guide for Defining Initial Conditions in Groundwater Flow Modeling* (ASTM D5610).

Substep C – Prepare a Water Budget

The sources/sinks of the system (recharge/discharge areas) as well as expected flow directions should be included in the HCM. The inflows include groundwater recharge from precipitation, overland flow, or recharge from surface water bodies. Outflows may include springflow, baseflow to streams, evapotranspiration, and groundwater pumping. The water budget summarizes the magnitudes (and ranges, as appropriate) of inflows and outflows, plus changes in storage. During calibration, this water budget will be compared to the water budget computed by the groundwater model.

Substep D – Define the Flow System

Typical data needed to define the flow system include hydrologic data (precipitation, evaporation, and surface water runoff), groundwater head data, and surface water flow. Water level measurements are used to define the general direction of groundwater flow, the locations of recharge/discharge areas, and the relationships between aquifers and surface water systems. Water chemistry data can be used to help define local or regional flow systems, flow direction, sources and amounts of recharge, and groundwater flow rates. Flow system definition will be performed in accordance with ASTM 5979.

Substep E – Conceptualize Contaminant Transport Inputs for HCM

The HCM should include components for contaminant transport within the system in accordance with ASTM D1689. Identification of the processes that are key to contaminant releases, contaminant migration, and environmental receptor exposure to contaminants are conceptualized in the HCM. Development of the transport system is critical in determining exposure routes. Basic activities needed to support the HCM include identifying key contaminants, including surrogates

and breakdown products, source zone(s) contribution, delineation of potential migration pathways through various media (e.g., vadose zone, groundwater, surface water), and determining background concentrations.

A rough outline of topics that should be considered for groundwater contaminant transport include:

1. Identifying which contaminants are to be included in the analysis.
2. Define physical and chemical properties of the contaminants and media:
   a. Mobility characteristics (partition coefficients, distribution coefficients, porosity).
   b. Mixing/spreading characteristics (3 components of dispersivity, molecular diffusion).
   c. Degradation (biological, order of decay, radioactive half-lives, daughter products and whether to consider).
   d. Dense Non-Aqueous Phase Liquid (NAPL)/Light NAPL.
   e. Available site specific data or SRS sitewide data.
3. Spatial distribution of contaminants (concentrations, plumes, maps, point data).
4. Temporal distribution of contaminants.
5. Characterization and representation of source(s):
   a. Importance in predictive simulations will dictate comprehensiveness of source term representation.
   b. Physical relationship of source to groundwater (vadose zone consideration).
   c. Physical properties of source (extent, spatial variability, inventory, infinite versus mass-limited).
6. Identifying migration pathways (initially may be done with maps, particle tracking, and the flow model).
7. Identifying and characterizing exit points from groundwater:
   a. Pumping wells
   b. Surface water (streams, creeks, lakes, rivers)
   c. Seeps
   d. Trees/vegetation

References

ASTM Standard D5609, 2016. *Standard Guide for Defining Boundary Conditions in Groundwater Flow Modeling*, ASTM International, West Conshohocken, PA.

ASTM Standard D5610, 2014. *Standard Guide for Defining Initial Conditions in Groundwater Flow Modeling*, ASTM International, West Conshohocken, PA.

ASTM Standard D5979, 2019. *Standard Guide for Conceptualization and Characterization of Groundwater Systems*, ASTM International, West Conshohocken, PA.

ASTM Standard E1689, 2020. *Standard Guide for Developing Conceptual Site Models for Contaminated Sites*, ASTM International, West Conshohocken, PA.

PROTOCOL

Groundwater Model Selection, Design, and Application

Introduction

This protocol has been developed to support the Savannah River Site (SRS) environmental remediation program. This protocol provides guidelines to follow when selecting, designing, and applying groundwater models at SRS. Although prepared with groundwater modeling applications in mind, much of the information contained herein pertains to general modeling principles and procedures that should also be applied when developing other types of environmental models (e.g., vadose zone and water balance models). The steps outlined in this document describe how to create a new numerical model well-suited to predict future conditions at SRS.

Details

Step 1 – Define Modeling Objectives

The first step in any modeling study (Figure 1) is to clearly define the modeling objectives ASTM Standard D5447). Refer to *Groundwater Modeling in the RCRA/CERCLA Process* (GW-1) for details regarding modeling objectives at SRS. These objectives should be the primary focus during all subsequent steps in the modeling process.

Step 2 – Develop a Conceptual Model

After all objectives have been identified, the second step is to develop a conceptual model (Figure 1). A hydrogeologic conceptual model (HCM) broadly describes the approximate direction of groundwater flow, the groundwater sources and sinks, the hydrostratigraphy, and other factors that affect the hydrogeologic system. A simplified geological cross-section or block diagram is often developed during this step to illustrate the elements of the HCM and their interactions with one another. Refer to *Developing the Hydrogeological Conceptual Model* (GW-2) for a description on how to develop an HCM in support of groundwater modeling.

Step 3 - Select Model Code(s)

After modeling objectives are defined and an HCM has been developed, the next step in groundwater model development is to select a computer program, or "code," to use. The code solves the governing equations that constitute the mathematical model. Different codes can solve different governing equations (e.g., the groundwater flow equations and advective-dispersive transport equations) or, in the case of numerical models, different codes can solve the same governing equation(s) using different numerical techniques. A wide variety of numerical modeling codes have been developed to simulate groundwater flow and transport.

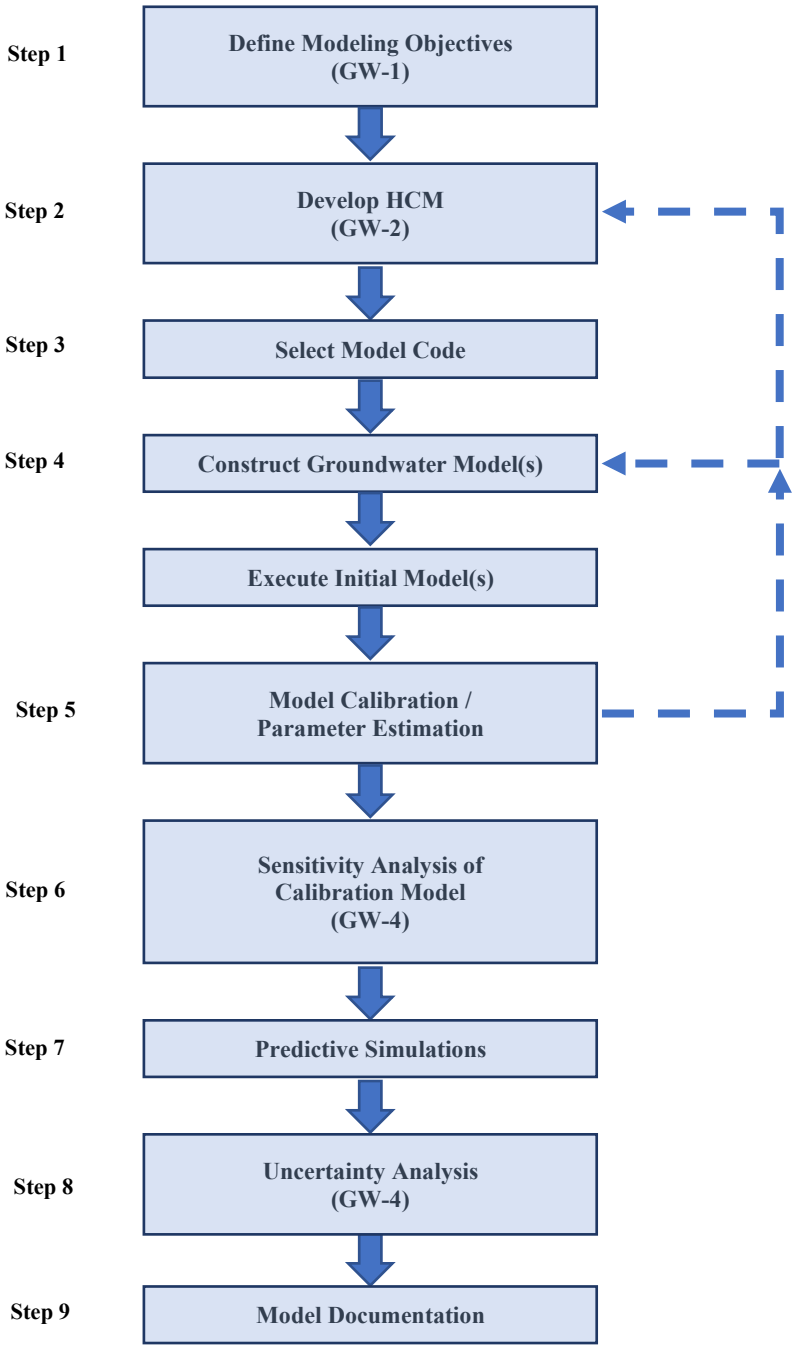


Figure 1. Modeling Process Workflow

Code selection should always be based on the HCM and modeling objectives (ASTM Standard D6170). The chosen code should have the following characteristics:

- The code should be capable of representing the HCM in sufficient detail to meet the modeling objectives.
- The code should be well-documented and verified (e.g., with test problems).
- If groundwater transport simulations are required to meet modeling objectives, compatible flow and transport codes—or a single code that incorporates simulation of both flow and transport—should be chosen.

Many modeling codes have graphical user interfaces (GUIs) that can be useful tools in model pre- and post-processing. However, these GUIs (1) do not necessarily incorporate all features and options of complex codes, and (2) can have programming errors that are not present in the modeling code itself. Caution should be taken when selecting and using interfaces to ensure that desirable features of the chosen code(s) are not restricted. Any additional limitations or modeling constraints imposed on users should also be carefully considered and documented before choosing to use such an interface.

Step 4 – Construct the Groundwater Model

Model construction is the process of formulating the HCM (see *Developing the Hydrogeological Conceptual Model* [GW-2]) as a mathematical model that the chosen code(s) can interpret (ASTM Standard D5447). Model datasets (inputs) are required to define the key components of the mathematical model: spatial and temporal domains, spatial and temporal discretization, boundary conditions, initial conditions, and physical properties (parameters).

Model Domain

The spatial extent of the modeling domain should be chosen based on the HCM and pre-specified modeling objectives. Major surface water features such as streams and lakes often form convenient lateral boundaries for groundwater flow domains, as do inferred and temporally stable groundwater flow paths. When such natural boundaries are not present within the area of interest, the lateral edges of the model domain should be set far enough from the primary area of interest (e.g., location of the contaminant plume) that uncertainty in lateral-edge boundary conditions can be expected to have minimal impact on the simulation objectives. When simulating solute transport using a structured model grid, the grid should ideally be oriented such that the prevailing groundwater flow direction in the area of primary interest is parallel to the grid rows or columns. This orientation reduces numerical (i.e., non-physical) dispersion of the solute transport numerical solution. The vertical domain of a groundwater model is typically from the land surface or water table to the top of an aquitard or aquiclude below the deepest aquifer of interest for the modeling study.

The temporal extent of the model should also be based on the modeling objectives. A steady-state model represents a single period in which inputs (e.g., groundwater recharge), stresses (e.g., groundwater pumping), and boundary conditions are constant. Steady-state modeling may be sufficient to meet the objectives of some modeling studies, whereas others may require transient

modeling in which inputs, stresses, and/or boundary conditions vary with time. The temporal domain (i.e., simulated time period) for a transient model should be chosen based on the availability of observations to define temporal changes in inputs, stresses, and boundary conditions.

Discretization

The spatial and temporal domains of numerical models must be subdivided. The spatial domain should be subdivided horizontally such that:

- All features of the HCM relevant to the modeling objectives (e.g., streams and rivers) can be represented in sufficient detail to meet the modeling objectives;
- The numerical solution of the relevant governing equation(s) is stable; and
- The run times of the model(s) is not prohibitively long (run times are generally proportional to number of model cells).

The hydrogeologic environment at SRS consists of multiple layered aquifers separated by confining and semi-confining units. Therefore, it is crucial to consider the impacts of three-dimensional groundwater flow and contaminant transport, and the subsurface beneath SRS must be discretized vertically to do so. When vertically subdividing the subsurface, it is generally best to use hydrostratographic unit (HSU) boundaries to define the top and bottom elevations of nonhorizontal model layers as opposed to using horizontal layers with uniform thickness (Harte, 1994). Depending on the relative thicknesses of each HSU resulting from this process, some or all of the HSUs may need to be subdivided. The modeling objectives should always be considered when vertically discretizing a groundwater model; transport models generally require finer vertical resolution than flow-only models in which the simulated quantities (i.e., groundwater heads) typically do not vary as much vertically as groundwater concentrations. It is important to note that increases in the spatial (vertical and horizontal) and temporal discretization often lead to increases in the time required to execute the model, and trade-offs between discretization and computational requirements may need to be considered. The model discretization is often shown as a figure with the horizontal (areal) grid overlain on a base map of the study area. Similarly, the vertical discretization or model layering is shown as the vertical grid overlain onto a typical geological cross section covering the model area.

Steady-state groundwater flow models solve the groundwater flow equation once and do not account for any temporal changes in the groundwater system; no time period is simulated. However, for models simulating transient groundwater flow and/or transport, the simulated time period must be subdivided into discrete periods (“time steps”). Enough time steps should be used in transient flow and transport simulations for the time-dependent flow and transport complexities (e.g., changes in contaminant source concentrations) to be represented by the model (Reilly and Harbaugh, 2004).

When simulating solute transport, the transport time steps do not necessarily need to coincide with the companion flow simulation’s time steps. Transport solution stability and convergence can be improved by the selection of time steps that are consistent with the model grid. The largest possible

time-step (Δt) in a transport simulation should not violate the following criterion anywhere in the model domain:

$$\left| v \frac{\Delta t}{\Delta x} \right| \leq 1$$

where v is the advective groundwater velocity and Δx is the grid cell size. This condition must be met to minimize numerical dispersion and maximize stability of the numerical solution.

Boundary Conditions

Groundwater Flow Boundaries

A critical part of developing a site-specific groundwater model is the definition of boundary conditions to represent physical boundaries and groundwater flow sources and sinks. There are four types of boundaries used in groundwater flow modeling: Dirichlet (specified head), Neuman (specified flux), Cauchy (head-dependent), and seepage face boundaries (ASTM Standard D5609). Specified head boundaries are used to represent hydrologic features at which certain heads are maintained during the simulation period, such as lakes or other large waterbodies. Specified flux boundaries are used to simulate conditions where water is either added or removed from the groundwater system at a given volumetric rate, such as recharge and groundwater injection and extraction wells. Head-dependent boundaries are used to represent locations where the flux across the boundary is dependent upon the model-simulated groundwater heads, such as discharge to a stream from a phreatic aquifer. Seepage face boundaries represent land surface locations where groundwater evaporates or flows to an adjacent surface waterbody (e.g., stream); however, flow across seepage face boundaries is typically ignored in large-scale groundwater models.

Groundwater Transport Boundaries

For groundwater transport models, boundary conditions representing contaminant sources may be required if a continuing source is present (or potentially present) and could impact the modeling objectives. The sources may be specified mass (or radioactivity) flux into the groundwater domain (e.g., from a vadose zone source) or an area or location of specified concentration. The nature of contaminants, their source(s), and the dominant physical processes (i.e., the HCM) should determine how contaminant boundary conditions are defined in a transport model. For example, the physical processes determining the dissolution of non-aqueous phase liquid (NAPL) below the water table differ from the dominant processes for vadose zone sources.

Additional tools and analyses (e.g., vadose zone flow and transport modeling, external mass balance calculations, or geochemical modeling) may be required to reduce uncertainty and increase credibility of the way(s) in which contaminant mass sources are represented in the groundwater transport model.

Groundwater flow and transport model boundaries may be shown on figures similar to those describing model discretization; in this case with symbols or color coding within cells to identify the type of boundary condition used.

Initial Conditions

Initial Groundwater Heads

Steady-state groundwater flow models do not require detailed initial conditions[1], however initial heads are required to simulate transient groundwater flow. In transient model simulations, the specified initial heads can potentially have a large impact on simulated results; therefore, the initial conditions should represent hydrologic conditions at the start of the transient simulation period as well as possible (ASTM Standard D5610). Initial heads should also be consistent with hydraulic parameters and model boundary conditions. The spatial distribution of initial heads is typically defined using model-simulated values from either a steady-state simulation or an antecedent transient simulation of sufficient length that any stresses during the antecedent period are insignificant.

Initial Groundwater Concentrations

Specifying initial concentrations may be necessary when simulating solute transport, particularly if the simulation period begins after contamination occurred. Initial concentrations may be specified based on spatial interpolation of measured groundwater concentrations or manual contouring of the concentration data. An alternative way to estimate current concentrations throughout the spatial domain is to calibrate mass sources, or source terms, in conjunction with the flow model calibration; concentration measurements can be used as calibration targets when attempting to replicate the historical development of contaminant plumes. However, caution should be exercised when considering a source term calibration because of the generally greater complexity (relative to specifying recent data-based concentrations as initial conditions for predictive simulations) and the many assumptions that may be required (e.g., regarding historical boundary conditions).

Step 5 – Model Calibration

When modeling objectives require solute transport simulations, it is generally preferable to calibrate the flow and solute transport models simultaneously. The only other reasonable alternative—sequentially calibrating the flow model parameters followed by the transport model parameters—neglects the fact that concentration data can be useful in refining flow model parameters (e.g., hydraulic conductivities and storage parameters). Transport parameters should generally be calibrated whenever solute transport is simulated if previous site-specific estimates do not exist.

Data Sets

High quality data are important for model calibration. Site-specific data should be used when available; however, literature-based data may be substituted for some parameters that are difficult

[1] Numerical simulation of steady-state flow benefits from using an initial estimate of the groundwater head field that reasonably approximates the expected steady-state conditions. Therefore, using an interpreted water-table map as initial conditions for a steady-state flow model may prove beneficial for model efficiency.

to obtain (e.g., dispersivity) or are common to a specific constituent (e.g., radioactive decay rate) or hydrogeological environment (e.g., maximum evapotranspiration rate). For temporally varying quantities such as water levels, concentrations, recharge, and streamflows, data based on a routine (monthly, quarterly, annual) monitoring plan are generally preferable. Data for calibration targets should be checked and/or validated prior to their use.

Determine Calibration Period

Selection of a suitable calibration period should be based on site-specific data availability and the modeling objectives. When a steady-state flow model is sufficient to meet modeling objectives, the model should be calibrated to more than one set of hydrologic conditions whenever possible. The steady-state flow calibration period(s) should be chosen based on two primary considerations:

1. There should be sufficient data during the calibration period to develop robust, representative calibration targets; and
2. The average hydrologic conditions (e.g., recharge and boundary conditions) during the calibration period should reflect those anticipated during the predictive period as closely as possible.[2]

A transient flow model calibration is preferable to a steady-state calibration whenever modeling objectives involve changes to the groundwater flow regime. The transient calibration period should be as long as necessary (given the relevant data available) and encompass as many different hydrologic conditions (e.g., high- and low-rainfall periods, wet and dry streamflow periods, etc.) as necessary to represent the period of interest[3] (ASTM Standard D5981/D5981M). When performing a transient calibration, it is desirable for the transient calibration period to end at the start of the predictive simulation period when possible; this enables a seamless transition from the calibration model period to the predictive period.

Define Calibration Targets

The availability of data suitable for defining calibration targets is an important factor in determining an appropriate calibration period. Suitable data that informs the calibration process can be divided into two categories: quantitative and qualitative targets. Quantitative information that can be used directly as calibration targets includes groundwater heads, flow rates (e.g., groundwater discharge to surface water), and dissolved groundwater concentrations. These data can also be used to derive additional quantitative targets to inform the calibration process, such as vertical differences in heads and concentrations between wells, horizontal differences in heads and concentrations, and temporal differences in heads and concentrations (transient simulations only).

[2] For example, if large-scale remedial measures influencing the groundwater flow system (e.g., extraction well networks) already exist and will continue to operate in the future, the preferred steady-state calibration period would be after the remedial measures were initiated.

[3] When simulating flow and transport, the two models' simulation periods do not necessarily need to coincide. If the period of record (POR) for groundwater head data is longer than the POR for concentration data, the flow model calibration period should be longer than the transport calibration period.

Qualitative information can also be used during the calibration process, either informally or in developing additional formalized (quantitative) calibration targets. Interpreted groundwater head contour maps can be compared to contours of simulated heads during calibration. Agreement between model parameters and any field-estimated aquifer parameters (e.g., hydraulic conductivity and storage parameters) can also be used to assess calibration quality and guide the calibration process.

Identify Calibration Parameters

The parameters that will be adjusted during the calibration process should be identified before beginning to calibrate. Calibration parameters do not necessarily need to be parameters explicitly represented in the modeling code. For instance, pilot points are often used in creating distributions of spatially varying properties (e.g., hydraulic conductivities) prior to executing a model, but pilot point values are not used directly by model codes. Although not model parameters in a strict sense, pilot point values are frequently specified as calibration parameters. Examples of typical calibration parameters are:

- Hydraulic conductivities (zoned or pilot point values used in preprocessing);
- Horizontal-to-vertical hydraulic conductivity anisotropy ratios;
- Storage properties (specific storage, specific yield, porosity);
- Boundary conditions (e.g., recharge rates); and
- Source mass or activity flux (for transport calibration).

Physically reasonable ranges of each calibration parameter should be defined prior to commencing the calibration process.

Pre-Calibration Analyses

It is important to be certain numerical models are numerically stable before calibration and that the results are conceptually reasonable. Numerical solver parameters including closure criteria should be configured such that the numerical solution converges and gives good (low) mass balance errors (Reilly and Harbaugh, 2004). Simulated water budgets (and solute mass budgets, if applicable) should also be calculated to determine if the relative importance of each water (or mass) source and sink is consistent with the HCM. Boundary conditions and initial calibration parameter values may need to be adjusted prior to calibration to be more consistent with the conceptual understanding of the groundwater system.

The initial model should be executed after all model pre- and post-processing procedures have been developed.[4] The initial model's level of fit to the calibration dataset should be assessed. Typical quantitative metrics of interest include the mean error (ME), mean absolute error (MAE),

[4] Starting with the initial model, it is good practice to maintain a run log that describes the model runs executed and the information gleaned from the run results.

and root mean squared error (RMSE) of concentration and potentiometric head residuals[5] and, if applicable, flow target residuals (ASTM Standard D5490). Qualitative and visual comparisons can also be useful in assessing model fit prior to calibration and in documenting the results: "scattergrams"[6], simulated and observed hydrographs and/or concentration versus time plots for individual wells, spatial error correlation maps, and temporal error correlation plots are all useful comparisons that can inform the calibration process. Monitoring and assessing the level of fit between simulated and target values throughout the calibration process is critically important in developing a reasonable, well-calibrated model.

It can be useful to define desired calibration metric goals before calibrating. However, preconceived metric goals should be developed with the understanding that failure to meet them will not necessarily preclude a model from being a suitable tool for achieving the model objectives. Calibration metric goals are typically based on the range in target values. For example, a model is generally considered to be well-calibrated if the ratio of the groundwater head MAE (or RMSE) to the range in head target values is less than 0.05 (5%) within an appropriate model area (e.g., the area of interest). Concentration-based calibration metric goals can be defined similarly but should generally be based on logarithmically transformed concentrations (e.g., RMSE of *log* C ≤ 0.5 * Range) when concentrations vary by orders of magnitude.

Parameter Adjustment

The goal of model calibration is to improve the model's fit to observations by adjusting calibration parameter values. Parameter values can be adjusted (estimated) manually, using an advanced automated method, or using a combination of multiple calibration methods (e.g., manual followed by automated). Manual calibration tends to be a more subjective process and can require greater effort than automated calibration methods. Automated methods use complex algorithms to systematically adjust parameter values such that one or more objective functions are minimized. Automated calibration techniques are generally preferred to manual calibration—due to their objectivity and automated, systematic approach—and are based on one of the following general concepts:

1. Determining the sensitivity of the objective function value(s) to small parameter perturbations and updating existing parameter values accordingly (gradient search methods);
2. Searching the full ranges of parameter values to find a parameter set with the lowest possible objective function value (global search methods); or
3. Using multiple initial parameters sets to assess parameter sensitivities and updating each parameter set until a group of well-calibrated models is defined (ensemble methods).

Gradient search (e.g., "PEST"; Doherty, 2020), global search, and ensemble methods have all been used to successfully calibrate numerical groundwater models. Each method has its own strengths

[5] Residuals are the differences between simulated and observed values for calibration targets (e.g., heads, concentrations). The preferred method of calculating residuals is to subtract the simulated value from the observed (target) value, which results an intuitive sign convention for residuals: positive residuals when the simulated value is higher than observed, and negative residuals when the simulated value is lower than observed.

[6] A plot of simulated versus observed values (ASTM Standard D5490). Alternatively referred to as "45-degree" plots.

and weaknesses, which should be understood before choosing a method. A notable strength of ensemble methods is that their use makes predictive uncertainty analyses straightforward (refer to *Sensitivity and Uncertainty Analysis for RCRA/CERCLA Groundwater Modeling* [GW-4]). It is often unclear at the start of the calibration process which method will be most effective and efficient at minimizing the objective function(s), so modelers should consider switching methods if the chosen method is either ineffective or inefficient at meeting the calibration objectives. If a satisfactory calibration cannot be achieved, the calibration method may not be at fault; the HCM and/or the numerical representation of it may need to be revised to be able to fit the numerical model to the calibration dataset (Figure 1).

Regardless of the calibration method used, regularization[7] should be employed during the calibration process. Regularization minimizes predictive error and ensures that estimated parameter values are unique. Well-calibrated but nonunique parameters can adversely impact model predictions (Freyberg, 1988).

Step 6 – Sensitivity Analysis

A sensitivity analysis of the calibration model should be conducted during or after the calibration process. This exercise will elucidate the influence of different parameters on the calibration quality. If a small change in one parameter, relative to its reasonable range, has a significant impact on calibration quality, then that parameter is well-constrained by the calibration process. Conversely, if changing the value of a parameter to any value within the reasonable range has no substantial effect on calibration quality, then the value of this parameter has not been constrained through calibration. The results of a sensitivity analysis are often assessed and illustrated using multiple plots, one for each parameter tested, which show the response of a calibration statistic to a range of parameter perturbations. Refer to *Sensitivity and Uncertainty Analysis for RCRA/CERCLA Groundwater Modeling* (GW-4) for guidelines to follow when conducting a sensitivity analysis.

Step 7 – Predictive Simulations

Following HCM development and simulation of the base case scenarios for the model, removal action conceptual model(s) (RACM) are developed to represent the remedial action alternatives for the OU. Remedial action alternatives for the system should be conceptualized to ensure full understanding of how alternatives will be modeled. The development of RACMs should consider whether the remedial action is to be represented external or internal to the F&T model. For example, source removal would be an external computation that would reduce or eliminate the source input to the model; whereas an extraction well system would be a boundary condition internal to the model.

Typically, when modeling remedial action alternatives, the results are modeled as opposed to the actual remedial process. For example, the estimated mass flux reduction is modeled for soil vapor extraction (SVE) systems, not the thermodynamic process of vapor exiting groundwater and being

[7] Regularization is the process by which uniqueness of solution to an inverse problem is achieved. The three main approaches to regularization are parameter simplification, singular value decomposition, and Tikhonov regularization (Doherty, 2015).

removed from the subsurface and remediated. If the process of remediation is to be modeled, this should be well defined in the RACM

A few examples of various remedial measures that may be represented include, but are not limited to, the examples presented in Table 1.

Table 1. Example Remedial Action Alternative Representation

Remedial Alternative	Representation	Common Name	Mechanism
Extraction Well	Specified flux boundary condition	Well	Dissolved contamination in groundwater removed
Injection Well	Specified flux boundary condition	Well	Mixes, redirects, or contains groundwater
Recirculation Well	Complex specified flux boundary condition	Well	Removal of a specified percent of contamination
Physical Barrier	Low permeability area or line	Low K wall	Containment or redirection of flow
Bio-barrier	Line of enhanced decay properties	1st order decay	Destruction of mass is enhanced across barrier
Bio-treatment	Area of enhanced decay properties	1st order decay	Destruction of mass is enhanced within area
SVE System	Reduce mass flux entering system	Injection well or recharge	Less contaminant mass enters groundwater
Capping	Reduction of specified flux boundary condition	Recharge	Mass flux is reduced

Each predictive simulation should be configured to align with one or more site-specific modeling objectives. Configuring the predictive model(s) typically involves modifying the calibration model to simulate a later (future) time period and the expected future boundary conditions and stresses (e.g., groundwater extraction and recharge). If large changes in stresses or major changes to boundary conditions are simulated, the impacts of these stresses and/or boundaries should be assessed during the uncertainty analysis (*Sensitivity and Uncertainty Analysis for RCRA/CERCLA Groundwater Modeling* [GW-4]).

Results of the predictive simulations are often the most important model results—they meet a practical purpose and were the motivation for developing the model. The results may be assessed and illustrated using, as examples: drawdown or plume maps for key time periods, plots of mass removal versus time, or water diversion from streams versus time. The specific illustration(s) will depend on the focus of the model. However, the predictive simulations are often not considered until the end of a modeling exercise and receive less thought and attention than earlier steps (e.g., model construction and calibration). As an alternative, it may be worthwhile to construct and execute predictive simulations simultaneously with the calibration model (i.e., prior to calibration process). A “forecast first” approach (White, 2017) can help inform the model construction, calibration, and prediction processes by offering opportunities to assess the effects of model construction assumptions and calibration parameters on model forecasts (predictions). Executing

predictions throughout the model development process can also provide insight into direct relationships between model inputs/parameters and predictions, which can be very useful during the predictive uncertainty analysis (see *Sensitivity and Uncertainty Analysis for RCRA/CERCLA Groundwater Modeling* [GW-4]).

Step 8 – Predictive Uncertainty Analysis

A groundwater model's predictions are inherently uncertain, and the goal of an uncertainty analysis is to understand and quantify the effects of model uncertainty on model predictions of interest. An uncertainty analysis of the model predictions should be performed during or after execution of the predictive simulations. Uncertainty in model results may be illustrated with plots of the range of outcomes of a particular occurrence (e.g., a drawdown limitation or concentration limit) for specific probabilities of occurrence. Refer to *Sensitivity and Uncertainty Analysis for RCRA/CERCLA Groundwater Modeling* (GW-4) for recommendations on conducting a predictive uncertainty analysis.

Step 9 – Model Documentation

The model development and application steps described above should be documented at the end of the modeling study. The report documenting the model should be organized in a logical way and consist of both written descriptions and supporting graphics (tables, maps, plots, schematics, etc.). At a minimum, the report should contain the following (ASTM Standard D5718):

1. Introduction section describing modeling objectives, how the model met these objectives, and important site-specific information;
2. Description of the HCM;
3. Description of the chosen computer code(s), including limitations and assumptions;
4. Details of how the numerical model was constructed and parameterized based on the HCM;
5. Description of how the chosen calibration method(s) were implemented;
6. Presentation of the calibrated model parameter values and calibration quality, including all quantitative metrics and qualitative comparisons to observations;
7. Summary of the sensitivity analysis, including identification of the parameters to which the calibration quality is most sensitive;
8. Presentation of predictive model and predictive uncertainty analysis results;
9. Final summary and conclusions focusing on how the model addressed the predefined modeling objectives; and
10. Model limitations.

The model documentation should be detailed enough to enable a thorough, critical review of the model's conceptual basis and numerical implementation. The model documentation should also contain sufficient figures to illustrate geographical, numerical, and statistical data that cannot be conveyed via text. Typical figures that are used for each step of the modeling process were identified in the previous eight sections.

References

ASTM Standard D5447, 2017. *Standard Guide for Application of a Numerical Groundwater Flow Model to a Site-Specific Problem*, ASTM International, West Conshohocken, PA.

ASTM Standard D5490, 2014. *Standard Guide for Comparing Groundwater Flow Model Simulations to Site-Specific Information*, ASTM International, West Conshohocken, PA.

ASTM Standard D5609, 2016. *Standard Guide for Defining Boundary Conditions in Groundwater Flow Modeling*, ASTM International, West Conshohocken, PA.

ASTM Standard D5610, 2014. *Standard Guide for Defining Initial Conditions in Groundwater Flow Modeling*, ASTM International, West Conshohocken, PA.

ASTM Standard D5718, 2013. *Standard Guide for Documenting a Ground-Water Flow Model Application*, ASTM International, West Conshohocken, PA.

ASTM Standard D5981/D5981M, 2018. *Standard Guide for Calibrating a Groundwater Flow Model Application*, ASTM International, West Conshohocken, PA.

ASTM Standard D6170, 2017. *Standard Guide for Selecting a Groundwater Modeling Code*, ASTM International, West Conshohocken, PA.

Doherty, J., 2015. *Calibration and uncertainty analysis for complex environmental models*. Watermark Numerical Computing, Brisbane, Australia. 227 pp.

Doherty, J., 2020. *PEST: Model-Independent Parameter Estimation User Manual, 7th Edition*, Watermark Numerical Computing, 393 p.

Freyberg, D.L., 1988. *An exercise in ground-water model calibration and prediction*. Groundwater 26 (3): 350-360.

Harte, P.T., 1994. *Comparison of vertical discretization techniques in finite-difference models of ground-water flow; example from a hypothetical New England setting*. U.S. Geological Survey Open-File Report 94-343, 25 p.

Reilly, T.E., and Harbaugh, A.W., 2004. *Guidelines for evaluating ground-water flow models*. U.S. Geological Survey Scientific Investigations Report 2004-5038, 30 p.

White, J.T., 2017. *Forecast first: An argument for groundwater modeling in reverse*. Groundwater 55 (5): 660-664.

This page is intentionally left blank.

PROTOCOL

Sensitivity and Uncertainty Analysis for Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act Groundwater Modeling

Introduction

This protocol has been developed to support the Savannah River Site (SRS) environmental remediation program. This protocol summarizes the basic concepts and steps for conducting sensitivity and uncertainty analyses specific to groundwater modeling efforts. Sensitivity analyses are performed to evaluate the calibrated model and relevant results. Uncertainty analyses are performed to assess the impacts of parameter, boundary condition, and/or model input uncertainty on model predictions of interest.

Details

Sensitivity Analysis

The objective of a sensitivity analysis is to identify the model parameters and inputs that are understood with minimal certainty or have the greatest effect on the results of a calibrated model (ASTM Standard D5611). Results evaluated are associated with the simulation of the historical (e.g., calibration) period simulated. Ideally the sensitivity analysis will inform how parameter sensitivity and variations in parameter values can affect the model results and overall objective of the modeling goal.

Identify Parameters to Assess

Prior to executing any sensitivity simulations, the decision must be made regarding whether to estimate sensitivities of all or a subset of the calibration parameters. Traditionally, a sensitivity analysis has involved selecting and adjusting a subset of the calibration parameters. Although potentially predicated on knowledge of the site, the hydrogeologic conceptual model (HCM), or the numerical model, the parameter selection criteria in such an analysis are subjective and, as such, the chosen subset of parameters does not necessarily include the most sensitive parameters. Despite not being comprehensive (i.e., including all calibration parameters), this traditional approach to conducting a sensitivity analysis can be useful; for models with very long run times and/or large numbers of calibration parameters, a comprehensive sensitivity analysis may not be feasible.

One advantage of developing a fully automated workflow prior to model calibration is that an efficient and tractable comprehensive sensitivity analysis of the calibration model becomes a realistic possibility. Automated calibration tools often have the capability of generating estimates

of parameter sensitivities directly in the form of a sensitivity matrix (e.g., PEST; Doherty, 2020). The sensitivity, or Jacobian, matrix contains partial derivatives representing changes in simulated outputs with respect to changes in parameter values. Alternatively, if it is desirable to analyze results from more than one model run per parameter, as is sometimes done in a traditional parameter sensitivity analysis, some automated calibration tools also have the capability of executing "batches" of model runs based on user-specified parameter sets (e.g., PESTPP-SWP; White et al., 2020).

A comprehensive sensitivity analysis is generally preferable to the traditional "one-at-a-time" method of assessing parameter sensitivities. However, both methods are acceptable, and the choice of method should be based on model runtimes, project objectives, and the financial and computing resources available.

Identify Model Outputs to Assess

Prior to executing any sensitivity simulations, the model outputs of interest should be identified. Examples include calibration quality metrics (e.g., mean absolute error of groundwater heads and/or concentrations), simulated water budget components (e.g., groundwater discharge to a river or spring), or groundwater heads or concentrations at specific locations (e.g., observation wells).

Execute Sensitivity Simulations

Before executing the sensitivity simulations, decisions must be made regarding the range of values to be simulated for each adjusted parameter. The parameter range should be based on the reasonable range of the physical property represented by the parameter, as determined during the model calibration analysis (see GW-3); for example, hydraulic conductivities and conductivity-based parameter (e.g., streambed conductance) ranges should typically be defined based on logarithmic scales whereas porosity ranges should be defined on a linear scale. Only physically reasonable values should be simulated.

The number of unique parameter values to simulate per model parameter must also be determined. It is generally best practice to execute simulations with at least one value lower and one value higher than the parameter's calibrated value.

After parameter ranges and the number of sensitivity simulations per parameter have been defined, the model simulations should be executed. After execution of each sensitivity simulation it should be confirmed that the simulation achieved satisfactory numerical convergence and mass balance results. An automated workflow can be used to both expedite this process and minimize the potential for human error.

Assess Parameter Sensitivities

The simulated effects of the adjustments to parameter values should be assessed after the sensitivity simulations have been executed. One common way of visualizing sensitivity simulation results is to plot changes to some model output (y-axis) as a function of the specified parameter

value (x-axis). Examples of model outputs that could be evaluated and plotted include goodness of fit metrics such as ME, MAE, or RMSE (defined in protocol GW-3) or key predicted outputs such as water levels, concentrations, stream flows, or mass flux at specific locations. These figures are often included in the model report. When using automated calibration tools to estimate parameter sensitivities, the overall sensitivity of the calibration dataset to changes in a parameter can be assessed (e.g., calculate mean sensitivities) or the sensitivity of individual (or groups of) observations to different parameters can be assessed.

The sensitivity analysis method chosen, the parameters adjusted (with justifications for their selection, if a comprehensive sensitivity analysis is not performed), and the assessment of parameter sensitivities should all be documented in the model report (ASTM Standard D5718; also see GW-3).

Additional Considerations

The discussion above focuses on sensitivity analyses for calibration models. Depending on project modeling objectives, it may be useful to conduct simultaneous sensitivity analyses of the calibration and predictive models in which the impacts of parameter changes are assessed for the calibration dataset and predictions of interest (e.g., groundwater concentrations at a discharge point). A major advantage of such an analysis is that parameters which do not impact calibration results but do impact predictive model results ("Type IV" sensitivity; ASTM Standard D5611) can be identified. If any Type IV parameters or inputs are found, these should be identified in the modeling report so future data collection efforts can be used to constrain these inputs.

Uncertainty Analysis

Uncertainty in groundwater modeling applications is unavoidable and can be attributed to numerous sources including (NGWA Groundwater Modeling Advisory Panel, 2017):

1. Conceptual model error (due to simplification of a complex physical system);
2. Parameter uncertainty (due to natural variability in the physical properties of the model domain);
3. Structural noise (due to imperfect fit of the mathematical model to the calibration dataset); and
4. Predictive error, or "scenario uncertainty" (due to uncertainty regarding future conditions, e.g., groundwater recharge rates).

Parameter Uncertainty Analysis

The uncertainty analysis procedures described below focus on parameter uncertainty. An uncertainty analysis can be viewed as an expanded form of sensitivity analysis, with the goal being to understand and quantify the effects of parameter uncertainty on model predictions of interest. Consequently, for practical reasons, all robust uncertainty analyses require an automated modeling workflow due to the large number of model simulations required. There is no single "best way" to assess predictive uncertainty; many different methods have been proposed and used to

successfully meet modeling objectives. Two of the many types of uncertainty analyses are described below; both are valid and useful under certain circumstances. Other options are introduced and described in general terms. The selection of which type of uncertainty analysis to perform in practice will depend on the modeling objectives and prior decisions made during the model development process.

The Monte Carlo method is ideally suited to the evaluation of model predictions that result from an investigation of the full range in plausible model parameter values. Such an investigation into parameter uncertainty can lead to the definition and inclusion of poorly calibrated models. Poorly calibrated models can be reviewed and potentially eliminated from the analysis, as long as doing so does not limit an evaluation of a robust spectrum of parameter values.

Conversely, an uncertainty analysis that is predicated upon calibrated parameter ensembles places greater importance on predictions made with reasonably well-calibrated models. In most cases, limiting the analysis to well-calibrated models precludes culling the ensemble of poorly calibrated models. However, this approach limits the investigation into ranges of model parameter values that are narrower than the ranges of plausible values. Accordingly, the calculated uncertainty in resulting model predictions may be lower than that produced by the Monte Carlo method. The stepwise guidance for each method is explained below.

Option 1 – Monte Carlo Method

1. Define reasonable ranges for each uncertain parameter. Reasonable ranges may be determined from statistical evaluation of site-specific field data or literature values that are based on similar physical conditions as the site or modeled area. Reasonable ranges encompass the possible values that a reasonable professional could assign to a subset of or entire model; it does not encompass outliers.
2. Sample a random value from each parameter's range. Typically, random values are selected from all parameters of interest concurrently, which produces a model realization.
3. Execute the realization of the calibration model using the randomly-sampled parameter set.
4. Repeat steps 2 through 3 a statistically sufficient number of times (as mentioned below).
5. Discard results from simulations that would not be considered realistic representations of the groundwater system during the calibration period. That is, retain only parameter sets which give results that would be considered "well-calibrated."
6. Execute predictive simulations using the retained, well-calibrated parameter sets.
7. Analyze predictive model results to determine if enough predictive simulations have been simulated for ergodicity[1] to have been achieved. If more well-calibrated parameter sets are required to achieve ergodicity, return to step 2 and repeat until ergodicity has been achieved.

[1] Ergodicity is achieved when statistical results (e.g., mean and variance) for a prediction of interest (e.g., groundwater concentrations at a groundwater discharge point) do not change with results from additional randomly-sampled, well-calibrated parameter sets.

8. Statistically summarize the predictions of interest for all realizations and include this summary in the model documentation.

The Monte Carlo method often requires thousands of model runs to achieve ergodicity and, as a result, can be prohibitively expensive in terms of computing time and human effort. For practical reasons, this method should only be used when model runtimes are short, a small number of parameters are considered uncertain and evaluated, and/or computational capacity is adequate to complete the uncertainty analysis in a reasonable timeframe relative to the duration of the modeling project.

Option 2 – Calibrated Parameter Ensembles

The process of eliminating poorly calibrated models during a Monte Carlo-type analysis can be avoided by using an ensemble calibration technique to identify multiple unique sets of well-calibrated parameters during calibration. Having many alternate parameter sets to use in executing an ensemble of predictive simulations makes a predictive uncertainty analysis very straightforward: each parameter set in the calibrated ensemble is used to simulate one predictive simulation. Major advantages of this approach are that it is relatively easy to implement and is the easiest predictive uncertainty analysis method for non-modelers (e.g., stakeholders and the public) to understand. Examples of ensemble calibration techniques include iterative ensemble smoothers (e.g., PESTPP-IES; White et al., 2020) and realization space inversion (e.g., RSI-HP; Doherty, 2021a).

Constraining a multi-realization uncertainty analysis to well-calibrated parameters can both limit the range within which model parameters are selected and evaluated and produce simulated model outcomes that may represent an underestimation of true uncertainty inherent in the modeled system. As such, calibration-constrained uncertainty analyses are not ideal for all modeling applications, and caution should be exercised when opting for this method of uncertainty analysis.

Quantifying Uncertainty for Predictions of Interest

The results of parameter uncertainty analyses - whether based on Monte Carlo realizations or well-calibrated parameter sets identified via ensemble methods - can be used in identical ways to assess the likelihood of certain outcomes during the predictive period. Consider a model developed to predict the concentration of a groundwater contaminant discharging to a surface waterbody. Each model realization predicts discharge concentrations throughout the predictive model period, and the predicted concentrations from all realizations can be summarized statistically. For example, the 5^{th} percentile (P5) and 95^{th} percentile (P95) discharge concentrations can be calculated throughout the simulation period. Time-series of the P5 and P95 concentrations can be plotted to illustrate the lower and upper concentrations, respectively, between which future concentrations are 90% likely to be. Using the same example, the probability of discharge concentrations being greater than a particular value (e.g., a contaminant regulatory limit) can be estimated at any time during the predictive simulation period based on the statistical distribution of concentrations through time. In this case, the probability of exceedance versus time would be plotted.

Other Parameter Uncertainty Analysis Options

Besides Monte Carlo and calibrated parameter ensemble methods, two other general categories of uncertainty analysis exist: linear and non-linear post-calibration ("posterior") analyses (Doherty, 2015; 2021b; 2021c). These analyses are advanced and less straightforward than either the Monte Carlo or calibrated parameter ensemble methods (Options 1 and 2 above). Expert knowledge is required when applying and interpreting the results of these methods and communicating their results to non-modelers in meaningful ways can be challenging.

Scenario Uncertainty Analysis

The descriptions above focused on analyzing parameter uncertainty, which is usually the extent of uncertainty analyses performed. However, as noted above, parameter uncertainty is only one source of predictive model uncertainty. For practical reasons, analyses addressing conceptual model error and structural noise are rarely undertaken. However, execution of a scenario uncertainty analysis can be less costly and should be considered because assumed (but unknowable) conditions during a predictive modeling period could have significant impacts on predictions. For example, suppose the duration of continued remedial groundwater pumping at existing remedial wells at SRS is assumed to be 30 years. It cannot be known with certainty that these wells would operate for 30 years, and the impacts of this assumption on predictions of interest cannot be known unless a scenario uncertainty analysis (in which other durations of remedial pumping are simulated) is performed.

Upon concluding the scenario uncertainty analysis/analyses, the uncertainties of model predictions should be summarized and documented in the model report (ASTM Standard D5718). Figures should be used to illustrate the uncertainty identified in the analysis. The types of figures will be problem specific but could include potentiometric surfaces and contaminant plume maps, or time series plots that illustrate the effect of uncertainty on the magnitude of key parameters (concentrations, heads, flows, mass flux, etc.).

References

ASTM Standard D5611, 2016. *Standard Guide for Conducting a Sensitivity Analysis for a Groundwater Flow Model Application*, ASTM International, West Conshohocken, PA.

ASTM Standard D5718, 2006. *Standard Guide for Documenting a Ground-Water Flow Model Application*, ASTM International, West Conshohocken, PA.

Doherty, J., 2015. *Calibration and uncertainty analysis for complex environmental models*. Watermark Numerical Computing, Brisbane, Australia. 227 p.

Doherty, J., 2020. *PEST: Model-Independent Parameter Estimation User Manual, 7th Edition*, Watermark Numerical Computing, 393 p.

Doherty, J., 2021a. *PEST_HP Compatible Programs for Highly Parallelized Computing Environments, Manual for Version 17.* Watermark Numerical Computing, October, 43 p.

Doherty, J., 2021b. *PEST Roadmap 12: Linear Analysis*. Tutorial and white paper available at https://pesthomepage.org/pest-roadmaps. Watermark Numerical Computing, 18 p.

Doherty, J., 2021c. *PEST Roadmap 13: Nonlinear Posterior Uncertainty Analysis.* Tutorial and white paper available at https://pesthomepage.org/pest-roadmaps. Watermark Numerical Computing. 11 p.

National Groundwater Association (NGWA) Groundwater Modeling Advisory Panel (GMAP), 2017. *Uncertainty in Groundwater Modeling*. White paper published by the, 9 p.

White, J.T., Hunt, R.J., Fienen, M.N., and Doherty, J.E., 2020. *Approaches to Highly Parameterized Inversion: PEST++ Version 5, a Software Suite for Parameter Estimation, Uncertainty Analysis, Management Optimization and Sensitivity Analysis*. U.S. Geological Survey Techniques and Methods 7C26, 52 p., https://doi.org/10.3133/tm7C26.

This page is intentionally left blank

PROTOCOL

Process for Use of Monitored Natural Attenuation and Groundwater Mixing Zone Application

Introduction

This protocol has been developed to support the Savannah River Site (SRS) environmental restoration program. This protocol is intended to provide guidance for establishing groundwater mixing zones, demonstration criteria required for pursuing the monitored natural attenuation (MNA) alternative, and the use of groundwater models in groundwater mixing zone applications. The objective is to ensure consistency in the SRS's application of groundwater mixing zones and use of MNA alternatives in groundwater modeling. The State of South Carolina Water Classifications and Standards Regulation 61-68 (R.61-68) applies to all groundwater of South Carolina. The South Carolina Department of Health and Environmental Control (SCDHEC) *Groundwater Mixing Zone Application Guidance* was followed for preparation of this guidance protocol.

Details

Process for Use of Monitored Natural Attenuation (Groundwater Mixing Zone) Alternative

Consideration of active cleanup measures is required for contaminants at concentrations that exceed regulatory limits (State Primary Drinking Water Standards). R.61-68 allows for establishment of "groundwater mixing zones," where contaminants may exceed applicable standards (e.g., maximum contaminant levels [MCLs]) if certain conditions are met. Groundwater mixing zones are areas downgradient from a source of contamination where concentrations are decreasing as a result of contaminant degradation, volatilization and/or mixing with the natural waters of the formation.

Each proposed mixing zone requires unique hydrogeologic information and assessment, depending on the contaminants present and conditions at the site. MNA as a remedial option may be suitable for the types of contaminants and conditions that exist at SRS.

Conditions for Establishing Groundwater Mixing Zones

The conditions for establishment of a groundwater mixing zone under R.61-68 include:

- Reasonable measures have been taken or binding commitments are made to minimize the addition of contaminants to groundwater and/or control the migration of contaminants in groundwater.
- The groundwater in question is confined to a shallow geologic unit that has little or no potential of being an Underground Source of Drinking Water (USDW), and discharges, or

will discharge, to surface waters without exceeding the surface water standards set forth in R.61-68.

- The contaminant(s) in question occurs within the bounds of the property (e.g., defined groundwater mixing zone at the operable unit [OU]) and there is minimum possibility for groundwater withdrawals (present or future) to create drawdown such that contaminants would flow outside of the property boundary.
- The contaminants or combination of contaminants in question are not dangerously toxic (e.g., concentration exceeds several orders of magnitude greater than the health-based criteria), mobile, or persistent.

If the four conditions for establishing a groundwater mixing zone are met, a case may be made for use of the MNA remediation alternative. In order to accomplish this, a groundwater mixing zone application must be approved by SCDHEC.

The steps required for reviewing the conditions at a specific site under consideration for a mixing zone application are:

Step 1 - Determine the relative toxicity of the contaminants, or combination of contaminants, present in groundwater. As a general rule, when concentrations of a contaminant (or contaminants) are several orders of magnitude greater than the health-based groundwater and surface-water criteria, MNA is not likely to be appropriate.

Step 2 - Determine the relative persistence and mobility of the contaminants in the aquifer(s). If the contaminants are long-lived (e.g., polychlorinated biphenyls) or highly mobile in groundwater, use of the MNA alternative will only be practical in limited cases where contaminant concentrations are close to the relevant health-based standards.

Step 3 - Determine which aquifer(s) are affected by existing contamination.

Step 4 - Evaluate the source of the contamination and the likelihood for additional spreading of contaminant plume(s). Consider source removal or mitigation (by capping, or through active or passive treatment, etc.), the type of contaminants (i.e., volatile organic compounds vs. metals or radioactive compounds), and the potential for additional contaminant transport.

Step 5 - Consider the likelihood of additional contamination of groundwater via transport of contaminant(s) through the soil column to groundwater. As part of this, consider vadose zone transport parameters; thickness of the vadose zone, vertical groundwater velocity, recharge rate, fractional organic content (f_{oc}), cation exchange capacity, etc. Use of vadose zone transport models (e.g., VZCOMML) or relevant equations may aid in this assessment.

Step 6 - Determine the potential for future use of shallow groundwater aquifers as an USDW.

Step 7 - Review analytical data to ascertain if contamination is limited to shallow aquifers and compare hydraulic head measurements in shallow and deep aquifers to assess vertical flow potential and possible flow across confining (or semi-confining) units.

Step 8 - Consult hydrostratigraphic maps and potentiometric maps to establish the relationship between flow in affected aquifer units/zones and surface water features. If aquifer(s)

are discharging to surface water, compare contaminant concentrations in groundwater from the well or borehole location nearest the discharge point to surface water standards (set forth in R.61-68).

Step 9 - Check contaminant plume maps to ensure that contaminant plume(s) do not extend beyond SRS property boundaries or into adjacent operable unit(s). Assess the possibility of commingling contaminant plumes. If commingling plumes exist, the concentrations of contaminants entering the operable unit under study must be considered as part of the groundwater mixing zone application.

Step 10 - Check for nearby production and remediation wells and determine the potential effects of pumping on contaminant plume geometry and trajectory.

Step 11 - Review available data on prevailing biogeochemical conditions within and downgradient of the contaminant plume (e.g., aerobic vs anaerobic conditions) to determine the likelihood of contaminant attenuation due to biodegradation and sorption.

Step 12 - ***(Optional)*** – If applicable, consider whether decay or biodegradation of contaminant(s) present will result in ingrowth of another contaminant of concern.

Demonstration Criteria for the Mixing Zone Application

Per SCDHEC guidance, the following must be specifically addressed in the mixing zone application. Typically, most of these criteria are part of the Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Report.

- Demonstration that the source has been removed, remediated, and/or contained to minimize additional contamination of the aquifer and/or prevent exposure to any receptor (also part of the first condition). Examples of sources can include specific units (e.g., solid waste units, above ground storage tanks, wastewater lagoons, etc.) or free-phase product (e.g., petroleum fuels, solvents, etc.).
- Demonstration that contamination in groundwater has been completely characterized by establishing the types and concentrations of contaminants that exist at the site. The parameters to be analyzed should include all components of the material released and their degradation products that are potentially water soluble.
- Definition of the horizontal/vertical extent of soil and/or groundwater contamination and plume movement (nature and extent of contamination should be reasonably understood). The vertical movement should be especially well documented in potential recharge areas.
- Demonstration that contaminants will remain confined in a shallow geologic unit until discharge to surface water or attenuation to standards (e.g., MCLs) occurs. The contaminants must not migrate to a deeper aquifer, causing exceedance of standards.
- Demonstration that the area or volume of contamination that exceeds standards is not significantly increasing prior to discharge or attenuation.
- Demonstration that contaminants (above standards) will not extend beyond property boundaries or the established compliance boundary. This is accomplished by groundwater flow and contaminant fate and transport modeling, or through other hydrogeologic

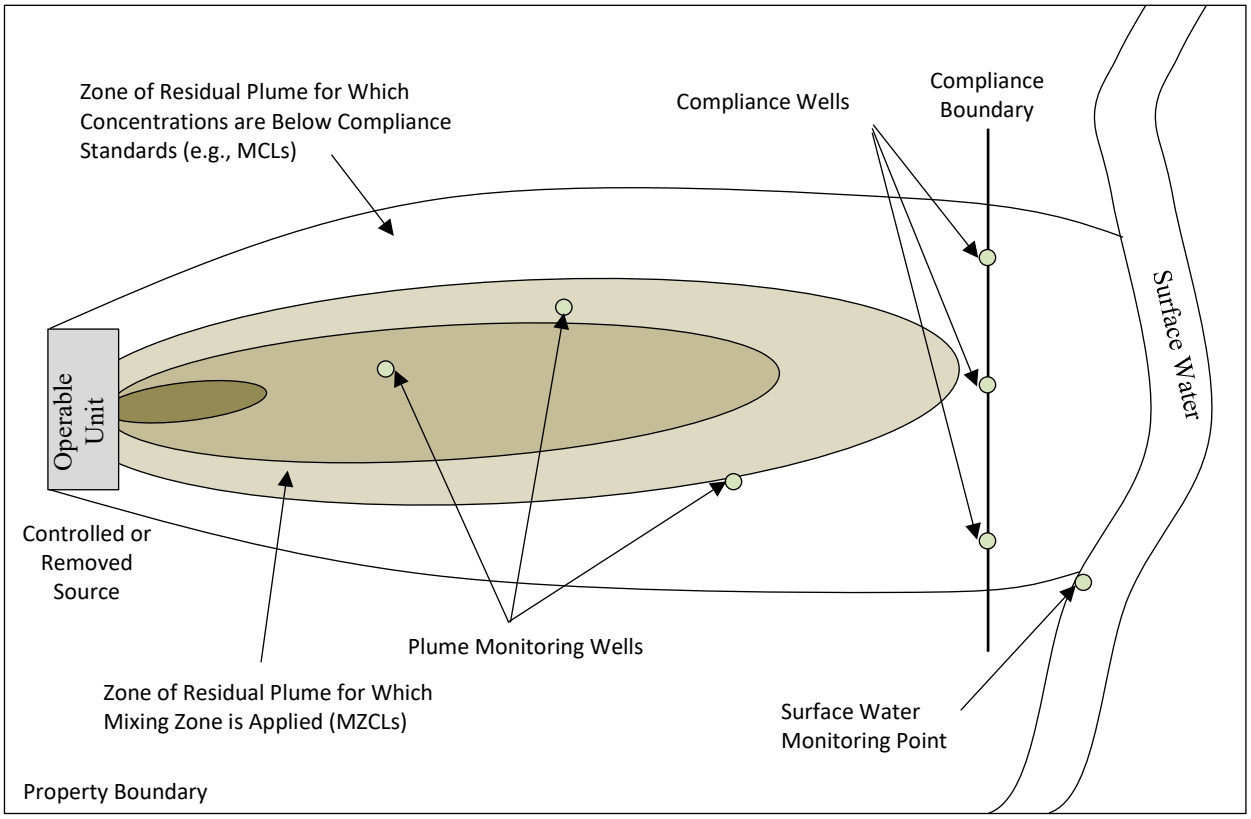
evidence (including calculations). Realistic values should be used in calculations and models; however, conservative values should be used for variables where uncertainty exists as a way to minimize the likelihood predicted values will be exceeded by actual data.

- Demonstration that potential receptors and exposure pathways (e.g., resident ingestions through drinking water wells) have been identified.
- Demonstration that there is no current use (and a minimum potential for future use) of affected groundwater as an USDW for the anticipated duration of the mixing zone status period.
- If groundwater discharges to surface water (on-site or at the property boundary), data must be obtained to identify the concentrations of contaminants and the rate of discharge to the surface water body. Documentation of in-stream water quality (surface water monitoring) is required and compliance with applicable standards must be maintained during the discharge. The predicted impact to any biological communities and the hydrologic characteristics of the stream or adjacent wetland are also components of this consideration.
- Site-specific mixing zone concentration limits (MZCLs) must be established for the site. MZCLs are often the highest concentration for the specific contaminants identified at the site.

Compliance Monitoring

As part of the groundwater mixing zone application, a monitoring program must be proposed to show compliance with mixing zone requirements and justify MZCLs for each contaminant present. The program must demonstrate compliance with; (1) MZCLs within source and/or the plume(s), and (2) applicable standards (e.g., MCLs) at compliance boundaries. Compliance boundaries are required near the down-gradient plume boundary, at property boundaries, or surface discharge areas. The monitoring program will continue until applicable standards within the plume are achieved.

Mixing zone scenario with monitoring network including groundwater discharge to surface water is shown in the following diagram:



To support compliance monitoring with surface water discharge, monitoring wells need to be installed at an appropriate distance between the former source and discharge area in order to monitor contaminant migration while allowing enough time to initiate a response action prior to surface water standard exceedances. Appropriate limits will be determined for the compliance boundary in order to ensure the protection of human health and the environment. Surface water monitoring will be necessary.

Use of Groundwater Modeling in Support of the Mixing Zone Application

Groundwater flow/contaminant transport models are useful for satisfying the requirements of groundwater mixing zone applications. Models may be used for the following:

1. Demonstrate site flow conditions and contaminant transport over time (horizontal and vertical migration).
2. Verify the time required for mixing zone status (exceeding regulatory status) and the area/volume effected.

3. Demonstrate that contaminants are highly unlikely to contaminate deeper aquifer zones (at concentrations greater than standards). Vertical movement must be especially well defined in potential recharge areas. If necessary, a formal uncertainty analysis may be performed in accordance with *Sensitivity and Uncertainty Analysis for Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act Groundwater Modeling* (GW-4).
4. Demonstrate that migration of contaminants at concentrations above applicable standards (e.g., MCLs) will not likely extend offsite. The demonstration must include the potential for groundwater use in the surrounding area (if this applies) that may result in contaminant flow offsite (for the time period the mixing zone will be in effect).
5. Identify appropriate down-gradient locations for compliance boundary wells.

The type of model selected (groundwater flow/contaminant transport) depends on the conditions at a particular site and the goals of modeling. Refer to *Groundwater Model Selection* (GW-3) for guidance in model selection, data evaluation, and model design/application.

PROTOCOL

Core Team Protocol for Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports

1.0 INTRODUCTION

For Savannah River Site (SRS) excess facilities undergoing disposition activities in the decommissioning phase, the United States Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) will participate in the decommissioning process as described in the Administrative Flow Path for Decommissioning Excess Facilities (Attachment 2 to the *Memorandum of Agreement for Achieving an Accelerated Cleanup Vision Savannah River Site*, July 2003). This protocol describes elements of the process for obtaining concurrence on the Facility Decommissioning Evaluation (FDE) and the Decommissioning Project Final Report (DPFR).

The FDE documents the rigorous and systematic review of all available information about a facility or group of facilities and is used to determine which decommissioning model (Simple Model, Integrated Sampling Model, or Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Model) is to be used for decommissioning. The United States Department of Energy (USDOE) has the option, with the concurrence of USEPA and SCDHEC, to forgo development of an FDE when additional information is not needed to support the use of a CERCLA action for a particular facility decommissioning project.

The DPFR is a document prepared for facilities that are decommissioned using the Simple Model or Integrated Sampling Model after the decommissioning activities have been performed and verified. The DPFR describes the decommissioning project activities and accomplishments and final facility status/end state. For CERCLA models, Removal Action Reports (RARs) or the appropriate post-remedial action documents are completed in lieu of DPFRs and will include cost and performance information.

The Core Team consists of representatives from the USDOE, USEPA, and SCDHEC with the responsibility to decide the need for and type of response to a known or potential threat to human health and the environment.

2.0 FACILITY WALKDOWNS

Facility walkdowns prior to decommissioning are an integral part of a facility decommissioning project and are scheduled at the request of the Core Team. If needed, SRS will prepare a schedule

for the Core Team to highlight those facilities that will be subject to a walkdown. A close-out meeting will be conducted upon completion of the walkdown.

If a walkdown is requested, the walkdown will be scheduled no sooner than ten (10) business days after submittal of the FDE to provide adequate review time by the Core Team.

The following guidelines will be utilized for facility walkdowns associated with facility decommissioning projects.

- SRS will provide briefing packages to the Core Team a minimum of five (5) working days prior to the walkdown. The briefing package will include the following:
  - Type of decommissioning model SRS intends to employ.
  - History of operations, process information, permits, environmental and waste management history, and/or suggested sampling locations (if any).
  - Copy of the floor plan will be available to aid in the discussion and selection of sampling locations (if any).
  - Additional supporting information (figures, spill reports, etc.) as appropriate.
- Close-out meetings will be held following the walkdowns to document discussions, resolve minor comments, verify selected sampling locations (as appropriate), and resolve any remaining issues.
- Meeting notes will be used, as appropriate, to document any agreements, comment resolutions, and other items. The meeting notes are prepared by SRS and will be provided to the Core Team and meeting attendees. Core Team concurrence and non-concurrence will be documented in the meeting notes.
- USEPA and SCDHEC will provide a formal concurrence or non-concurrence letter at a later date. The USDOE will provide responses to any comments received.
- See Sections 4.0, 5.0, and 6.0 for information on additional walkdowns that may be required.

3.0 FACILITY DECOMMISSIONING EVALUATIONS

The FDE assessment is used to determine which decommissioning model (Simple Model, Integrated Sampling Model, or CERCLA Model) is to be used for the facility based on the facility history, process knowledge, visual inspections, and identification of potential or presumed conditions that could pose a potential for release of a hazardous substance. A description of each decommissioning model is provided below.

- Simple Model – Designed for clean facilities where there have been no hazardous releases within the facility or to the environment. The only potential risk is safety risks for workers who perform decommissioning activities. Following decommissioning, the administrative disposition for Simple Model facilities is Federal Facility Agreement (FFA) Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation, as documented in the DPFR.

- Integrated Sampling Model – Designed for low hazard chemical facilities and other industrial facilities that may contain small amounts of contamination from former operation activities. Following decommissioning, the administrative disposition for Integrated Sampling Model facilities is either FFA Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action; or FFA Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation, as documented in the DPFR.
- CERCLA Model – Designed for nuclear facilities (Hazard Category 2 or 3), radiological facilities, and high hazard chemical facilities. Although an FDE can inform the selection of the CERCLA Model, USDOE has the option, with concurrence of USEPA and SCDHEC, to forgo development of an FDE when additional information is not needed to support use of a CERCLA action for a facility decommissioning project. The DPFR administrative pathway is not implemented for CERCLA Model facilities. Rather, the USDOE, USEPA, and SCDHEC reach concurrence on the CERCLA administrative path and CERCLA documentation. The CERCLA Model was formerly titled the Engineering Evaluation/Cost Analysis Model in earlier facility decommissioning documentation but was renamed to allow for the ability to select from multiple CERCLA administrative pathways (i.e., Removal Action, Early Remedial Action, standard Remedial Action, etc.).

The transmittal memo will identify that upon receipt of the FDE, USEPA and SCDHEC will either approve and/or comment on the FDE with the goal of responding within forty-five (45) days of receipt. The USDOE will respond in writing to USEPA and SCDHEC comments on FDEs, regardless of the decommissioning model.

The process for each decommissioning model is discussed in Sections 4.0 through 6.0.

The document distribution process is discussed in Section 8.0.

4.0 SIMPLE MODEL

For facilities undergoing decommissioning using the Simple Model, USDOE will seek concurrence on the FDE from USEPA and SCDHEC.

If comments are received on the Simple Model FDE, USDOE will prepare comment responses and e-mail responses to USEPA and SCDHEC with the goal of responding within thirty (30) calendar days.

USDOE will call (if necessary) and discuss the responses to comments with the goal of obtaining e-mail concurrence within fourteen (14) calendar days of sending the responses. Decommissioning activities are allowed to proceed based on informal (e.g., via e-mail) approval by SCDHEC and USEPA on the draft responses. After verbal discussion and agreement (if necessary), the USDOE will submit the revised responses (as applicable) in a formal transmittal letter to SCDHEC and USEPA to obtain formal concurrence on the Simple Model or agreed upon administrative path forward.

Concurrence on the Simple Model FDE establishes that upon completion of decommissioning and the approval of the facility DPFR, the facility/remnants can be transferred to Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation.

If during decommissioning of a Simple Model facility, some condition is identified that may contradict the Simple Model assumption, SCDHEC and USEPA will be notified in writing. SRS will evaluate the new condition with the FDE Evaluation Checklist and provide justification on whether the facility should remain as a Simple Model. If requested, SCDHEC and USEPA will be provided an opportunity to inspect the facility if safe to do so. Any facility walkdowns/inspections must be scheduled and conducted expeditiously.

If the facility warrants further evaluation for response action, the DPFR will reflect the findings and will recommend that the facility be added to Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action.

If, for some reason, a Simple Model facility slated for decommissioning is not decommissioned, it will remain in Appendix K.1, D&D Facilities to be Decommissioned.

5.0 INTEGRATED SAMPLING MODEL

Typically, sampling and analysis is used to support a final verification survey for a facility/remnants decommissioned using the Integrated Sampling Model. With agreement from the USEPA and SCDHEC, observation of the potential or presumed condition and/or field screening may be used to disposition a facility/remnants if the potential or presumed condition is not evident and/or conditions are not appropriate for verification sampling.

If a final verification survey is performed, identification of sampling points is determined as follows:

- If USEPA and SCDHEC are unable to provide input on sampling locations during the initial facility walkdown (if held) as described in Section 2.0, a follow-up walkdown will be scheduled if requested by either USEPA or SCDHEC. The walkdowns will be scheduled during the forty-five (45) day FDE review period.
- The USEPA and SCDHEC may provide written input on sampling locations with the goal of responding during the forty-five (45) day FDE review period. If USEPA or SCDHEC specifies any additional sampling points, the sampling locations will be identified and submitted to USDOE along with comments and/or concurrence on the FDE.

If comments are received on the Integrated Sampling Model FDE, USDOE will prepare comment responses and e-mail responses to USEPA and SCDHEC with the goal of responding within thirty (30) calendar days.

USDOE will call (if necessary) and discuss the responses to comments, as required, with the goal of obtaining e-mail concurrence within fourteen (14) calendar days of sending the responses. Decommissioning activities are allowed to proceed based on informal (e.g., via e-mail) approval by SCDHEC and USEPA on the draft responses.

After verbal discussion and agreement (if necessary), the USDOE will submit the revised responses (as applicable) in a formal transmittal letter to SCDHEC and USEPA to obtain formal concurrence on the Integrated Sampling Model or agreed upon path forward.

Disposition of the facility/remnants to Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action or Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation will be based on the following criteria:

- When a final verification survey is performed, sampling and analysis of sampling points agreed to by USEPA and SCDHEC will be used to determine residual contaminant levels. If a comparison of sampling results to contaminant thresholds identifies the potential for an unacceptable risk greater than 1×10^{-6} for unrestricted use, the facility/remnants will be transferred to Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action.
- During or after decommissioning, if the potential or presumed condition is evident through observation or field screening, the facility/remnants may be dispositioned to Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action with USEPA and SCDHEC approval for final characterization under the FFA Remedial Investigation/Feasibility Study program.
- During or after decommissioning, if the potential or presumed condition is not evident through observation, field screening, and/or residual contaminant levels, the facility/remnants may be dispositioned to Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation with USEPA and SCDHEC concurrence.

The technical basis and proposed disposition of the facility/remnants to FFA Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action or FFA Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation will be documented in the DPFR.

If, for some reason, an Integrated Sampling Model facility slated for decommissioning is not decommissioned, it will remain in Appendix K.1, D&D Facilities to be Decommissioned.

6.0 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) MODEL

For facilities undergoing facility decommissioning by means of the CERCLA Model, USDOE will seek concurrence on the appropriate CERCLA documentation from USEPA and SCDHEC.

After the decommissioning is completed under CERCLA, the appropriate post-removal action documentation (i.e., RAR) or post-remedial action documentation (i.e., Post Construction Report (PCR), Corrective Measures Implementation Report/Remedial Action Completion Report (CMIR/RACR), or PCR/CMIR/RACR) will be submitted to the USEPA and SCDHEC for their review and comment or approval in accordance with the process specified in the FFA.

If, for some reason, a CERCLA Model facility slated for decommissioning is not decommissioned, it will remain in Appendix K.1, D&D Facilities to be Decommissioned.

7.0 DECOMMISSIONING PROJECT FINAL REPORT (SIMPLE MODEL AND INTEGRATED SAMPLING MODEL)

The transmittal memo for each DPFR will recommend the administrative disposition for the facility/remnants, specifically referring the facility/remnants to Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action, or Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation.

The USDOE will submit Revision 0 of the DPFR to USEPA and SCDHEC for their review and comment and/or concurrence with the goal of responding within sixty (60) calendar days of receipt. A walkdown following decommissioning activities will be scheduled if requested by either USEPA or SCDHEC.

If comments are received on the Revision 0 DPFR, USDOE will provide written responses to comments and e-mail the responses to the USEPA and SCDHEC with the goal of responding within thirty (30) calendar days.

USDOE will call (if necessary) and discuss the responses to comments, as required, with the goal of obtaining e-mail concurrence within fourteen (14) calendar days of sending the responses.

After verbal discussion and agreement (if necessary), the USDOE will submit the final comment responses and a Revision 1 DPFR (as applicable) to USEPA and SCDHEC for their review and concurrence with the goal of responding within thirty (30) calendar days of receipt.

Once review of the comment responses and/or DPFR has been completed such that there is consensus as to the administrative path for the facility/remnant, the facility/remnant will be placed on Appendix C.4, D&D Facilities (or remnants) that May Warrant Response Action, or Appendix K.2, D&D Facilities (or remnants) that Require No Further Evaluation.

8.0 DOCUMENT DISTRIBUTION

The USDOE will submit FDEs, DPFRs, and comment responses to the USEPA and SCDHEC (see Table 1 below). As needed, the USDOE will e-mail draft comment responses to the USEPA and SCDHEC for their review prior to official submittal of the responses.

Table 1. Distribution of FDEs, DPFRs, and Comment Responses Submitted to USEPA and SCDHEC from USDOE

Office	Position	Distribution
SCDHEC	Manager, Federal Remediation Section, SCDHEC Columbia Office	Letter, hard copy of documents and/or responses, compact disc (CD)
	SCDHEC Aiken Environmental Affairs Office	cc: Letter, hard copy of documents and/or responses, CD
USEPA	SRS Remedial Project Manager (RPM), Superfund Division	Letter, hard copy of documents and/or responses, CD

Note:
1. The project specific USEPA RPM is copied on all correspondence and receives copies of documents and/or responses and CDs by mail or electronic transfer, as applicable.

The USEPA and SCDHEC will submit comments on FDEs and DPFRs and subsequent approval letters to the USDOE (see Table 2 below).

Table 2. Distribution of Comments on FDEs, DPFRs, and Approval Letters Submitted to USDOE from USEPA and SCDHEC

Office	Position	Distribution
USDOE	SRS RPM, Infrastructure and Area Completion Division	Letter (e-mail advance copy)
SRNS	Director, Environmental Compliance & Area Completion Projects	cc: Letter (e-mail advance copy)

Notes:
1. USEPA will copy Manager, Federal Remediation Section (SCDHEC – Columbia) and SCDHEC Aiken Environmental Affairs Office on concurrence letters and comments sent to USDOE.
2. SCDHEC will copy USEPA SRS RPM, Superfund Division and if needed, project specific USEPA RPM, on concurrence letters and comments sent to USDOE.
3. SRNS should receive the original hard copy for placement in the Administrative Record File.

Any changes to the distributions listed above shall be communicated in writing (e-mail or letter) to the other Parties.

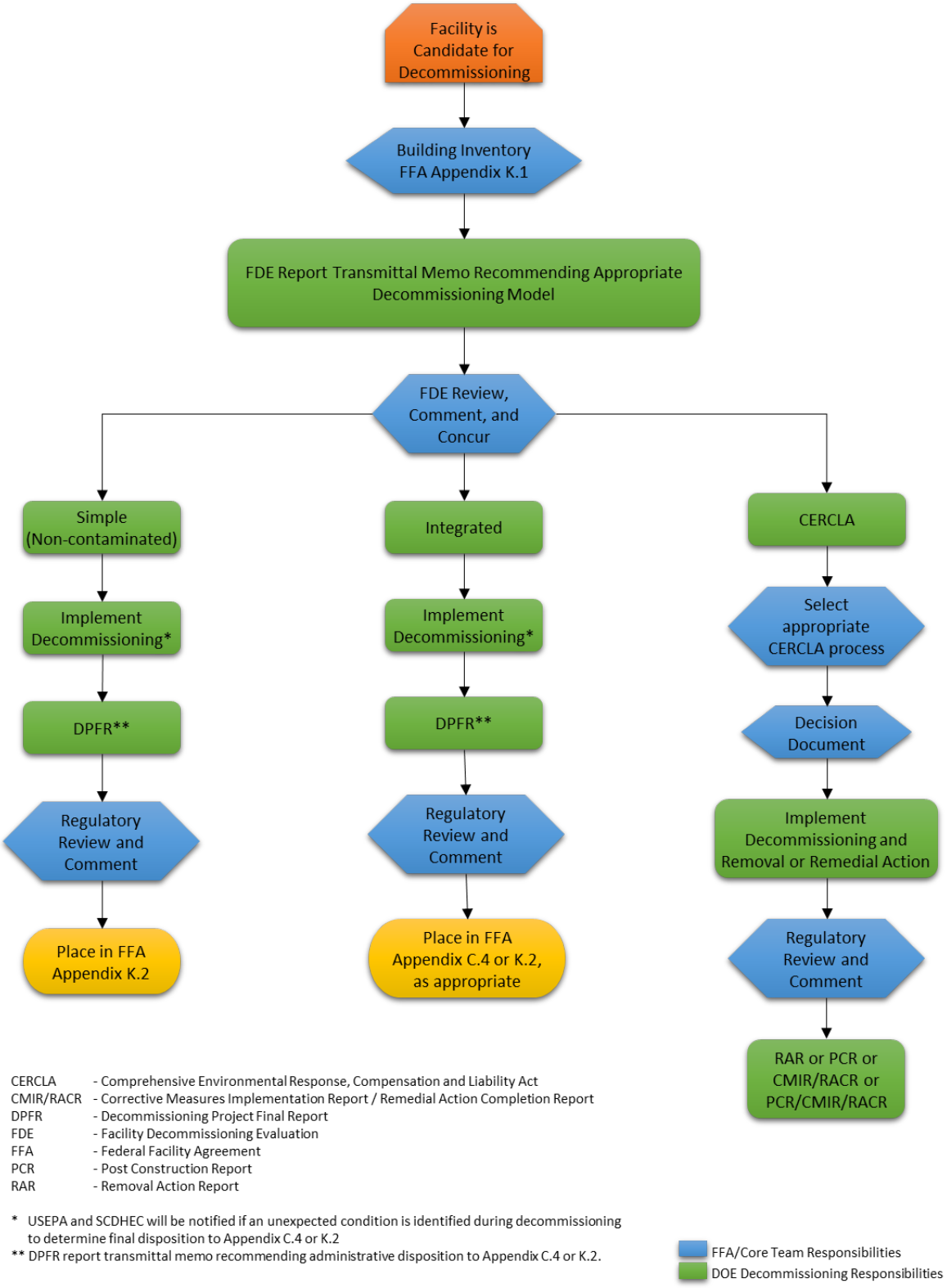


Figure 1. Decommissioning Planning Process

PROTOCOL

Core Team Protocol for Reuse of Federal Facility Agreement Decommissioned Excess Facilities

1.0 INTRODUCTION

The Savannah River Site (SRS) is a thriving site within the United States Department of Energy (USDOE) Complex. In addition to ongoing long term National Nuclear Security Administration (NNSA) missions conducted at the Savannah River Tritium Enterprise facilities in H Area, SRS was selected for important NNSA missions in F and K Areas. In fact, SRS has transitioned from an Environmental Management (EM) Site to a NNSA Site. EM missions such as Area Completion will continue until those missions are completed.

Under the SRS Deactivation and Decommissioning (D&D) program, excess facilities to be decommissioned are located on the Federal Facility Agreement (FFA) *Appendix K.1, D&D Facilities to be Decommissioned.* Following decommissioning, these facilities (or remnants) are assigned to *Appendix C.4, D&D Facilities (or Remnants) that May Warrant Response Action* or *Appendix K.2, D&D Facilities (or Remnants) that Require No Further Evaluation* (FFA 1993). The footprint associated with excess facilities (or remnants) that have undergone decommissioning may have the potential to be repurposed to support new NNSA missions.

The *Core Team Protocol for Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports* describes the process SRS uses to engage the Core Team (i.e., representatives from the USDOE, U.S. Environmental Protection Agency [USEPA], and South Carolina Department of Environmental Services [SCDES])[1] in managing excess facilities undergoing D&D (SRNS 2022). This *Core Team Protocol for Reuse of Federal Facility Agreement Decommissioned Excess Facilities* describes the process to engage the Core Team on decisions involving reuse/repurposing of excess D&D facilities (or remnants). The process will rely on existing documents, established approaches, and tools that are familiar to the Core Team to evaluate decommissioned facilities (or remnants) for reuse/repurposing.

USDOE[2] will coordinate with other SRS entities requesting to reuse a D&D facility (or remnant) to ensure that area closure milestones are not impeded.

.

[1] SCDES was known as the South Carolina Department of Health and Environmental Control prior to July 1, 2024.
[2] USDOE (Savannah River Operations Office)

2.0 DECOMMISSIONING MODELS AND DOCUMENTATION

The Facility Decommissioning Evaluation (FDE) is used to secure Core Team input on the appropriate decommissioning model. The three types of decommissioning models are the Simple Model, Integrated Sampling Model (ISM), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Model. Core Team input and concurrence are sought on the FDE. The FDE, primary references, and regulatory feedback are placed in the SRS Administrative Record File (ARF).

- The Simple Model is designed for clean facilities where there have been no hazardous releases within the facility or the environment. Following decommissioning, the administrative disposition for Simple Model facilities is FFA *Appendix K.2, D&D Facilities (or Remnants) that Require No Further Evaluation*.
- The ISM is designed for low hazard chemical facilities and other industrial facilities[3] that may contain chemical and/or radiological contamination from former operation activities. Following decommissioning, the administrative disposition for ISM facilities is FFA *Appendix K.2, D&D Facilities (or Remnants) that Require No Further Evaluation* or *Appendix C.4, D&D Facilities (or Remnants) that May Warrant Response Action.*
- The CERCLA Model is used for nuclear facilities (Hazard Category 2 or 3), Radiological Facilities[4], and high hazard chemical facilities to support a CERCLA action for a facility decommissioning project. For CERCLA Model facilities, the USDOE, USEPA, and SCDES reach concurrence on the CERCLA administrative path and documentation. Facilities (or remnants) decommissioned under the CERCLA Model are likely managed under regulatory approved land use controls that will impact their availability for reuse/repurposing.

The Decommissioning Project Final Report (DPFR) is used to communicate the details of the decommissioning project, the condition of the resultant D&D facility (or remnant) and proposes the administrative path for the D&D facility (or remnant) for Simple and ISM Model facilities. DPFRs for ISM decommissioning projects typically include the results of a final verification survey that documents the chemical or radiological condition of the resultant D&D facility (or remnant). Core Team input and concurrence are sought on the DPFR. The DPFR, primary references, and regulatory feedback are placed in the ARF.

3.0 PROCESS FOR EVALUATING D&D FACILITIES (OR REMNANTS) FOR REUSE/REPURPOSING

The process for evaluating D&D facilities (or remnants) located on FFA *Appendix K.2, D&D Facilities (or Remnants) that Require No Further Evaluation*, or *Appendix C.4, D&D*

[3] USDOE defines "Other Industrial Facility" as a facility with all radiological or chemical hazards below 40 CFR 302.4 thresholds (SRS 2020, USEPA 2004).
[4] USDOE defines "Radiological Facility" as a facility below Hazard Category 3 Nuclear that still contains quantities of radioactive material at or above 40 CFR 302.4 reportable quantities (SRS 2020, USEPA 2004).

Facilities (or Remnants) that May Warrant Response Actions, is described below. A graphic representation of these steps is provided in Figure 1.

FFA Appendix K.2, D&D Facilities (or Remnants) that Require No Further Evaluation

Conditions that placed excess facilities (or remnants) on Appendix K.2 as allowed by the *Core Team Protocol for Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports* (SRNS 2022) include the following:

- Decommissioned with the Simple Model and no information was discovered to warrant further evaluation;
- Decommissioned with the ISM and the Core Team agreed that the final verification survey confirmed the contaminant migration and human health risk results require no further evaluation (Example - FFA Path Forward for PAR Pond Buildings 651-6G, 681-7G, and 735-7G and Ancillary Facility Remnants [USDOE 2021]); or
- Relocated from FFA *Appendix C.4 D&D Facilities (or Remnants) that May Warrant Response Action* after further evaluation by the Core Team concluded that the potential or presumed condition is not evident through observation, field screening, and/or residual contaminant levels (Example – Transfer of Paint Shop Building [725-A] to Appendix K.2 [SRNS 2023b]).

Actions required for reuse/repurposing Appendix K.2 D&D facilities (or remnants), as shown in Figure 1, include the following:

- Savannah River Nuclear Solutions (SRNS) will provide written communication to USDOE documenting the new use. USDOE will propose to the Core Team written communication declaring the intention to reuse/repurpose an FFA Appendix K.2 D&D facility (or remnant) for a new use, allowing 45 days for feedback from USEPA and SCDES. If there are no objections from a Core Team member, the D&D facility (or remnant) will be made available for reuse/repurposing and remain on FFA Appendix K.2 with a footnote identifying the reuse/repurposing status. If the reuse/repurpose results in assignment of a new structure identification number, the footnote will be amended to include the structure identification number.

FFA Appendix C.4, D&D Facilities (or Remnants) that May Warrant Response Action

Conditions that placed facilities (or remnants) on Appendix C.4 include the following:

- Decommissioned with the ISM and final verification survey relied on human health risk and contaminant migration evaluations using the initial D&D program approach that differed from technical protocols applied in the FFA CERCLA remedial process (SRNS 2023a);

- Decommissioned with the ISM and final verification survey concluded that the human health risk was between 1E-04 to 1E-06 and did not support unrestricted land use (i.e., < 1E-06) in the FFA CERCLA program; or
- Decommissioned with the ISM based on regulatory comment on the FDE even though the decommissioning process supported use of the Simple Model because the D&D facility (or remnants) lacked the presence of radioactive or chemical contaminants.

Actions required for reuse/repurposing FFA Appendix C.4 D&D facilities (or remnants), as shown in Figure 1, include the following:

- For facilities (or remnants) on FFA Appendix C.4 under consideration for reuse/repurposing, a reevaluation of the human health risk and contaminant migration analysis will be performed on the DPFR final verification survey results applying the approved FFA CERCLA remedial process protocols (SRNS 2023a). A weight-of-evidence discussion (i.e., uncertainty evaluation) will be included as appropriate.[5]
- If the D&D remnants remain a viable candidate for reuse/repurpose after reevaluation of the DPFR human health risk and contaminant migration analysis and/or resolution of any outstanding DPFR comments from USEPA and SCDES, the results of the reevaluation will be provided to the Core Team by email and/or meeting as appropriate. The reevaluation will confirm the conditions that placed the facility (or remnant) on FFA Appendix C.4 are no longer present or appropriate. A recommendation will be made to transfer the facility (or remnant) to FFA Appendix K.2 in accordance with the *Core Team Protocol for Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports* (SRNS 2022) that allows ISM DPFRs to assign facilities (or remnants) to FFA Appendix K.2 when appropriate.
- USDOE will submit a letter to the USEPA and SCDES requesting approval to transfer the FFA Appendix C.4 D&D facilities (or remnants) to FFA Appendix K.2. If approval is received, the facilities or remnants are eligible for reuse/repurpose.
- If USEPA and SCDES do not approve transfer of the FFA Appendix C.4 D&D facilities (or remnants) to FFA Appendix K.2, the facilities (or remnants) will remain on Appendix C.4 and not be available for reuse/repurpose unless USDOE is able to satisfactorily address specific issues identified by USEPA and SCDES that preclude regulatory acceptance of the reuse/repurpose.

4.0 REFERENCES

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

SRNS, 2022. *Core Team Protocol for Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports,* SRNS-RP-2021-00120, Revision 1, August 2022

[5] Further action may be required prior to Core Team approval (see Figure 1).

SRNS, 2023a. *Environmental Compliance and Area Completion Projects Regulatory Document Handbook*, SRNS-RP-2022-00330, Revision 0, June 2023

SRNS, 2023b. *Scoping Summary for the Automotive Repair Shop (716-A) and Paint Shop Building (725-A) Operable Unit (U), RI Work Plan Characterization*, SRNS-RP-2023-00820, October 2023 (Final)

SRS, 2020. *SRS Procedure Manual 11Q, Facility Safety Document, Procedure Appendix-B Glossary*, Savannah River Site, Aiken, SC.

USDOE, 2021. *Savannah River Site Responses to the Regulatory Comments on the Decommissioning Project Final Reports for Building 681-7G, Par Pond Pump House Equipment Building (V-PCOR-G-00023, Revision 0, September 12, 2011), Building 735-7G, PAR Pond Environmental Support Facility (V-PCOR-G-00022, Revision 0, September 12, 2011), and Federal Facility Agreement Path Forward for Buildings 651-6G, 681-7G, and 735-7G and Ancillary Facility Remnants* (IACD-21-133, April 21, 2021)

USEPA, 2004. 40 CFR 302.4, *Designation of Hazardous Substances*, Title 40, Code of Federal Regulations, Part 302, U.S. Environmental Protection Agency, Washington, DC, April 2004.

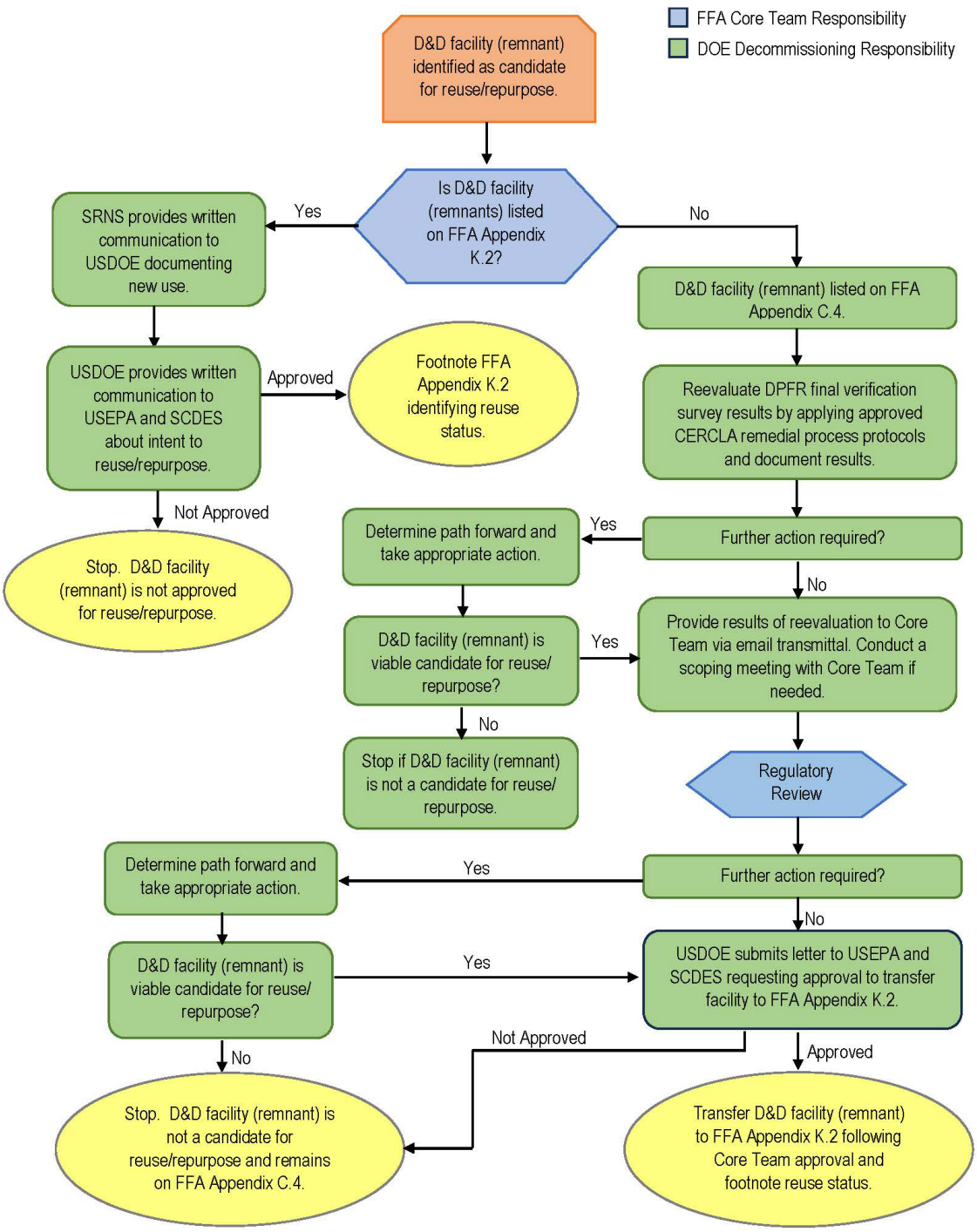


Figure 1. D&D Facility (Remnant) Reuse/Repurposing Process (corrected)

Appendix A

Record of Modifications

This page is intentionally left blank.

Table A-1. Record of Modification to the EC&ACP Regulatory Document Handbook

Date	Format/ Protocol Number	Format/Protocol Name	Modification
6/2023	All	Entire Handbook	Former EC&ACP Regulatory Document Handbook (ERD-AG-003, Revision 17, June 2012) was updated and replaced with EC&ACP Regulatory Document Handbook (SRNS-RP-2022-00330, Revision 0, June 2023).
6/2023	D-1	Core Team Protocol For Review and Concurrence on Facility Decommissioning Evaluations and Decommissioning Project Final Reports, Revision 1	Protocol D-1, Revision 1, was a standalone protocol in the SRS ARF that was added to the EC&ACP Regulatory Document Handbook (SRNS-RP-2022-00330, Revision 0, June 2023).
12/2025	Cover Page	Cover Page	Revised Cover Page to add "Updated December 2025" to reflect an update to the EC&ACP Regulatory Document Handbook.
12/2025	D-2, F-6	Table of Contents	Added new Protocol D-2, Core Team Protocol for Reuse of Federal Facility Agreement Decommissioned Excess Facilities, Revision 0, to Module 10 – Decommissioning (D). Updated Protocol F-6 to Revision 1.
12/2025	D-2	Core Team Protocol for Reuse of Federal Facility Agreement Decommissioned Excess Facilities, Revision 0	Added new protocol D-2 to the EC&ACP Regulatory Document Handbook (SRNS-RP-2022-00330, Revision 0, June 2023, updated December 2025). Protocol D-2 was approved via email by SCDES and USEPA on 7/31/2025 and 8/11/2025, respectfully.
12/2025	F-6	Statement of Basis/Proposed Plan Format, Revision 1	Based on USEPA comments[1], the standard statement that supports the need for taking action in the Conclusion section was revised to conform with the standard language in the USEPA guidance, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, OSWER Directive 9200.1-23P, July 1999.
1/2026	D-2	Core Team Protocol for Reuse of Federal Facility Agreement Decommissioned Excess Facilities, Revision 0	Based on USEPA comments[2], corrected term "ruse" to "reuse" in Figure 1 in three locations. Renamed Figure 1, "D&D Facility Remnant Reuse/Repurposing Process (corrected)".

[1] USEPA Comments on the Statement of Basis/Proposed Plan for the Early Construction and Operational Disposal Site L-3 (NBN), L-Area Rubble Pit (131-1L), and L-Area Rubble Pit (131-4L) Operable Unit (U) (SRNS-RP-2025-00724, Revision 0, June 2025).

[2] USEPA Comments on the EC&ACP Regulatory Document Handbook (SRNS-RP-2022-00330, Revision 0, June 2023, updated December 2025) (Redline Pages and Clean Copy), received 1/8/2026.

Table A-1. Record of Modification to the EC&ACP Regulatory Document Handbook (continued/end)

Date	Format/ Protocol Number	Format/Protocol Name	Modification
1/2026	Cover Page	Cover Page	Revised Cover Page to included “corrected” in the title to reflect the editorial correction of Protocol D-2, Figure 1.

Appendix B

Scoping Phases

This page is intentionally left blank.

Figure B-1. The Five Scoping Phases

The five scoping phases correspond with critical points in the Remedial Investigation/Feasibility Study (RI/FS) process and are focused on refining the following key project decisions of each operable unit (OU).

- Concise and accurate problem definition(s);
- Clearly defined remedial action objectives;
- Scope of problem(s) warranting action;
- Early identification of likely response actions; and
- Uncertainties that will need to be resolved or managed over the course of the project.

The emphasis on communicating technical information and reaching agreement on key project decisions prior to formalizing information in the standard RI/FS documentation is critical. At each of the five scoping phases, a scoping meeting will be held, and an OU Scoping Summary will document decisions and uncertainties that influence the key project decisions. Information presented in the scoping summaries will be updated to reflect the current technical understanding and Core Team agreements at every phase in the project life-cycle. Accordingly, information and project agreements will become more refined as the project progresses from planning to implementation. Instances where agreement cannot be reached represent uncertainties that warrant further discussion and/or technical evaluation. Explicitly identifying what is not known and determining which unknowns have a significant impact on decision making ensures that issues are resolved in a timely manner and establishes a clear link between technical work and remedial decisions.

Information/Data Gathering

Work Plan Scoping Phase

This phase occurs prior to the development of the RI/FS Work Plan. Available data and information are used to consider all key project decisions for the *life-cycle* of the project, including likely response actions. Preliminary project decision will be documented in the Work Plan Scoping Summary. The scoping summary should be accompanied by maps, data summary tables including relevant screening values, a preliminary conceptual site model (CSM), and contamination cross-sections or maps that support project decisions. Thorough and focused identification of data needs for the entire life-cycle of the project and data quality objectives (DQOs) should be established at this phase prior to any investigative efforts. Any uncertainties identified during this phase will drive the scope of the Work Plan and RI investigative efforts. A vital result of Work Plan scoping is a mutual understanding of site conditions, which is crucial in determining additional information necessary for the RI.

Possible Supporting Tools:

- Pre-Work Plan characterization data
- Process history
- Initial data screening table
- Preliminary CSM
- Initial site map/maps of findings
- Preliminary cross-section

Post-Characterization Scoping Phase

This phase occurs after initial data collection and before the risk assessment and modeling are conducted. Information gathered during characterization efforts is used to refine the key project decision and determine if there is enough quality data and information to complete the RI protocols (e.g., contaminant of concern [COC] screening, risk screening, risk assessment, modeling, etc.). During this scoping phase, the Core Team should agree that DQOs were satisfied, determine the discrete exposure groups to be evaluated individually through a risk assessment, and decide what types of modeling are necessary, if any. The refined project decisions will be documented in the Post-Characterization Scoping Summary.

Possible Supporting Tools:

- Updated data screening table
- Refined CSM
- Updated site map/maps of findings
- Updated contaminant cross-sections with screening exceedances
- Summary of significant changes in technical understanding since the Work Plan Scoping
- DQO fulfillment matrix

Data Evaluation/Problem Identification

Problem Identification Scoping Phase

This phase occurs after implementation of the RI protocols but before development of the RI report. Information resulting from the RI protocols is used to identify any significant changes in technical understanding prior to complete the RI report. During the Problem Identification Scoping Phase, the Core Team should revise all key project decisions in light of new information. At the end of this phase, the Core Team ***must reach agreement*** on the problems warranting action, remedial action objectives, and scope of the problem, which will be documented in the Problem Identification Scoping Summary. Once this phase is complete, the project team can complete the RI report

Possible Supporting Tools:

- Updated data screening table with risk assessment and COC screening results
- Refined CSM
- Updated site map/maps of findings
- Updated contaminant cross-sections accounting for various preliminary remedial goals
- Summary of significant changes in technical understanding since the Post-Characterization Scoping

Feasibility Study Scoping Phase

This phase occurs after problem identification and prior to development of the FS report. During this phase, the Core Team should identify any outstanding information that will be necessary to effectively evaluate and select response actions, resulting in a decision on the final range of alternatives to be analyzed in detail. The Core Team should also conduct a preliminary evaluation against the three CERCLA screening criteria to determine the key discriminators and develop a hierarchy of response actions. Any uncertainties identified in this phase represent data gaps warranting further discussion and/or technical evaluation to be provided in association with the FS.

Possible Supporting Tools:

- Results of the RI protocols
- RI Report
- Refined CSM illustrating exposure pathways broken by response actions
- Visual representation of scope of problem(s)
- Summary of treatability/pilot studies conducted and results
- Table of likely response actions screened against effectiveness, implementability, and cost criteria
- List of applicable or relevant and appropriate requirements (ARARs), to-be-considered criteria, and USDOE Orders.

Remedy Evaluation & Selection

Proposed Plan Scoping Phase

This phase occurs prior to development of the Proposed Plan (PP). Based on the analysis provided by the FS, the Core Team will agree upon the preferred response action and rationale to be presented in the PP.

Possible Supporting Tools:

- Approved FS
- Summary table from FS of the likely response actions screened against CERCLA criteria

This page is intentionally left blank.