Savannah River NUCLEAR SOLUTIONS℠

Focused Early Action Corrective Measures Study/Feasibility Study in Support of Beneficial Reuse of Select Coal Ash and Coal Fines at the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), F-Area Ash Landfill (288-F), H-Area Ash Basin (288-H), K-Area Ash Basin (188-K), and L-Area Ash Basin (188-L) Operable Units

SEMS Numbers: 61, 62, 88, 90, & 91

SRNS-RP-2024-00222

Revision 1

May 2025

SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

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Savannah River Nuclear Solutions, LLC
Aiken, South Carolina

CERTIFICATION

Focused Early Action Corrective Measures Study/Feasibility Study in Support of Beneficial Reuse of Select Coal Ash and Coal Fines at the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), F-Area Ash Landfill (288-F), H-Area Ash Basin (288-H), K-Area Ash Basin (188-K), and L-Area Ash Basin (188-L) Operable Units

SEMS Number(s): 61, 62, 88, 90, and 91
SRNS-RP-2024-00222, Revision 1, May 2025

[REF: 40CFR270.11 (d)(1)]

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EXECUTIVE SUMMARY

In 2022, the United States Department of Energy proposed a wholistic remedial approach to the U.S. Environmental Protection Agency and South Carolina Department of Environmental Services for remaining coal ash and coal fines operable units at the Savannah River Site. The remedial approach includes the evaluation of beneficial reuse of ash material as a fill material or concrete additive rather than managing as a waste material that requires excavation and disposal or containment by an engineered cover system. This document is a Focused Early Action Corrective Measures Study/Feasibility Study which discusses remedial action objectives and preliminary remedial goals to support beneficial reuse of the ash material for five coal ash and coal fines operable units that include the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), F-Area Ash Landfill (288-F), H-Area Ash Basin (288-H), K-Area Ash Basin (188-K), and L-Area Ash Basin (188-L). The five operable units are listed as Resource Conservation and Recovery Act/Comprehensive Environmental Compensation, and Liability Act units in Appendix C of the Savannah River Site Federal Facility Agreement.

Savannah River Site submitted the *Preferred Remedial Action and Regulatory Strategy for Remaining Savannah River Site's Coal Ash and Coal Fines Operable Units (U)* in July 2022 to the U.S. Environmental Protection Agency and South Carolina Department of Environmental Services for regulatory review and approval. The regulatory agencies agreed that existing data for these coal ash and coal fines operable units was sufficient for the development of a Focused Early Action Corrective Measures Study/Feasibility Study. The U.S. Environmental Protection Agency and South Carolina Department of Environmental Services approved the implementation and administrative strategy for the coal ash and coal fines operable units on August 11, 2022, and September 22, 2022, respectively.

The purpose of this document is to support the early action remedial strategy for the remaining coal ash and coal fines operable units that is protective of human health and the environment and mitigates the effects of contamination which will ultimately result in beneficial reuse of ash material. For the remedial alternative evaluation, the five coal ash and coal fines operable units represent three types of operable units based on unit type, quantity of available data, and level of data assessment.

The A-Area Ash Pile and A-Area Coal Pile Runoff Basin Operable Unit was investigated via the Resource Conservation and Recovery Act Remedial Investigation/Feasibility Study process in 2008 and documented in the approved *Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit*. The dataset data and evaluation supporting the human health and ecological risk assessments, contaminant migration analysis, and principal threat source material evaluation was sufficient, and no additional data collection or evaluation to support the evaluation of remedial alternatives presented in this report is needed.

The human health risk assessment identified arsenic, potassium-40, radium-226, and uranium-238 as refined constituents of concern. There were no principal threat source material or contaminant migration refined contaminants of concern identified for either the A-Area Ash Pile or the A-Area Coal Pile Runoff Basin.

For the H-, K-, and L-Area Ash Basins, three ash/soil samples were collected from each of the three basins from the 0 to 0.3 meters (0 to 1 foot) surface interval in 2020 to compare the data to other remediated operable units with similar ash-related contaminants (i.e., arsenic and naturally occurring radionuclides) and to support the evaluation of remedial alternatives presented in this report. Surface ash/soil samples were also collected for geophysical analyses. Per Core Team (i.e., representatives from the U.S. Department of Energy, U.S. Environmental Protection Agency, and the South Carolina Department of Environmental Services) agreement, the three samples from each of the three ash basins were combined into one database and evaluated in accordance with the protocols in the *Environmental Compliance & Area Completion Projects Regulatory Document Handbook*.

The concentrations of ash-related contaminants were found to be consistent with other ash units at the Savannah River Site and also comparable within the H-, K, and L-Area Ash Basins, as well as the F-Area Ash Landfill. The F-Area Ash Landfill is an active Class II Landfill (South Carolina Department of Environmental Services Solid Waste Landfill) that received ash from the A-, F-,

and H-Area powerhouses during its operational history. Per Core Team agreement, the H-, K-, and L-Area Ash Basin dataset was also applied to the F-Area Ash Landfill.

The human health evaluation identified the refined constituents of concern for the H-, K-, and L-Area Ash Basins and F-Area Ash Landfill as arsenic, potassium-40, thorium-232, and uranium-238 for the resident and industrial worker scenarios.

The contaminant migration analysis identified contaminant migration refined constituents of concern for the H-Area Ash Basin Operable Unit (barium, uranium-233/234, uranium-235, uranium-238) and the L-Area Ash Basin Operable Unit (barium).

No ecological or principal threat source material refined constituents of concern were identified at the remaining coal ash and coal fines operable units.

The remedial action objectives for the remaining coal ash and coal fines operable units are the following:

- For all remaining coal ash and coal fines operable units, prevent human exposure to contaminants present in the surface ash/soil that present a risk to the future resident and industrial worker greater than 1E-06 risk threshold or above background levels.
- For H-Area and L-Area Ash Basins, protect groundwater resources from migration of contaminants in surface ash/soil that would impact the groundwater above groundwater protection standard limits.

The three alternatives evaluated in the Focused Early Action Corrective Measures Study/Feasibility Study against the nine Comprehensive Environmental Compensation, and Liability Act criteria listed in the National Contingency Plan include the following:

- Alternative A-1: No Action
- Alternative A-2: Land Use Controls with Beneficial Reuse
- Alternative A-3: Class III Cover with Land Use Controls

Alternative A-1 is used as a baseline case to compare against the nine criteria of the other alternatives as required by the National Contingency Plan. Alternative A-2 assumes coal ash and

coal fines remain at the operable units with land use controls until the ash material is needed for beneficial reuse. Alternative A-2 is expected to achieve clean closure (i.e., unrestricted land use) for the operable units following excavation and removal of the coal ash and coal fines. For operable units with contaminant migration risk (i.e., H-Area Ash Basin and L-Area Ash Basin), groundwater will be monitored until the ash material is needed for beneficial reuse. Alternative A-3 does not consider beneficial reuse and assumes coal ash and coal fines remain in place beneath a Class III cover system with land use controls and groundwater monitoring. All alternatives, with exception of the No Action alternative, can attain the remedial action objectives.

The comparative analysis of remedial alternatives presented in this document does not propose a preferred alternative. Rather, the preferred alternatives will be presented in the Statement of Basis/Proposed Plan document to be submitted to the regulatory agencies following approval of this Focused Early Action Corrective Measures Study/Feasibility Study. A subsequent Record of Decision documenting the selected remedial actions for the five operable units is scheduled for issuance in February 2027.

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximately
AAP	A-Area Ash Pile
ac	acre(s)
ACPRB	A-Area Coal Pile Runoff Basin
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirements
As	Arsenic
Ba	Barium
bgs	below ground service
BMP	best management practices
BRA	Baseline Risk Assessment
CCR	Coal Combustion Residuals
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CM	Contaminant Migration
CMS/FS	Corrective Measures Study/Feasibility Study
COC	Constituents of Concern
CSM	Conceptual Site Model
EC&ACP	Environmental Compliance and Area Completion Projects
ERA	Ecological Risk Assessment
FAL	F-Area Ash Landfill
FCMS/FS	Focused Corrective Measures Study/Feasibility Study
FFA	Federal Facility Agreement
ft	foot/feet
GA	Gordon Aquifer
GCU	Gordon Confining Unit
ha	hectare(s)
HAB	H-Area Ash Basin

HH	Human Health
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IWT	Industrial Wastewater Treatment
K-40	Potassium-40
KAB	K-Area Ash Basin
km	kilometer(s)
km^2	square kilometer(s)
LAB	L-Area Ash Basin
LUC	Land Use Controls
m	meter(s)
m^3	cubic meter(s)
MAAZ	M-Area Aquifer Zone
mi / mi^2	mile(s) / square mile(s)
NCP	National Oil and Hazardous Substances Contingency Plan
O&M	Operation & Maintenance
OU	operable unit
PRG	Preliminary Remedial Goal
PTSM	Principal Threat Source Material
Ra-226	Radium-226
RAO	Remedial Action Objective
RCOC	Refined Constituents Of Concern
RCRA	Resource Conservation and Recovery Act
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SB/PP	Statement of Basis/Proposed Plan

SCDES	South Carolina Department of Environmental Services[1]
SDU	Saltstone Disposal Unit
SEMS	Superfund Enterprise Management System
SRS	Savannah River Site
SRNS	Savannah River Nuclear Solutions, LLC
TAL	Target Analyte List
TBC	to-be-considered
TCCZ	Tan Clay Confining Zone
TCL	Target Compound List
TCR	Total Cumulative Risk
TES	threatened, endangered, and sensitive
Th-232	Thorium-232
U-233/234	Uranium-233/234
U-235	Uranium-235
U-238	Uranium-238
UAZ	Upper Aquifer Zone
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
UTRA	Upper Three Runs Aquifer
WSRC	Washington Savannah River Company, LLC
yd / yd^3	yard(s) / cubic yard(s)

[1] SCDES was known as the South Carolina Department of Health and Environmental Control prior to July 1, 2024.

1.0 INTRODUCTION

This Focused Early Action Corrective Measures Study/Feasibility Study (FCMS/FS) discusses remedial action objectives (RAOs) and preliminary remedial goals (PRGs) for the A-Area Ash Pile (AAP) (788-A) and A-Area Coal Pile Runoff Basin (ACPRB) (788-3A) Operable Unit (OU), F-Area Ash Landfill (FAL) (288-F) OU, H-Area Ash Basin (HAB) (288-H) OU, K-Area Ash Basin (KAB) (188-K) OU, and the L-Area Ash Basin (LAB) (188-L) OU in support of beneficial reuse. The five OUs addressed in this FCMS/FS are herein called the remaining coal ash and coal fines OUs at the Savannah River Site (SRS). Beneficial reuse opportunities for coal ash and coal fines includes fill material for other facilities as part of a cover system or as an additive or replacement for cement in concrete mixes. Given that the specific beneficial reuse for each selected receiving facility will be identified at a future date, the remedial alternatives evaluated in this report support an early action for the remaining coal ash and coal fines OUs so that the ash material will be available when needed.

The goals of the remedial actions evaluated in this FCMS/FS are to protect human health and the environment and to mitigate the effects of contamination. The United States Environmental Protection Agency (USEPA) has established a structured process to identify and evaluate technologies for remedial applications. This process involves developing and screening a range of appropriate remedial options and selecting the most suitable approach(es) for corrective measures and remedial actions. As agreed to during project scoping, the alternatives evaluated in this report are focused on the most likely remedies that support beneficial reuse of ash material.

1.1 Purpose and Organization of Report

The purpose of this FCMS/FS is to assess remedial alternatives for the remaining coal ash and coal fines OUs at the SRS that have been identified as candidates for beneficial reuse of ash material.

This FCMS/FS was developed in accordance with Comprehensive Environmental Recovery, Compensation, and Liability Act (CERCLA) guidance. The general approach to evaluating potential remedial actions in the FCMS/FS is based on United States Department of Energy

(USDOE) guidance, USEPA guidance, and Core Team agreements. The Core Team is comprised of representatives from the USDOE, USEPA, and South Carolina Department of Environmental Services (SCDES) who are the remedial decision makers for the project.

The FCMS/FS provides discussion to:

- Summarize the results of the ash characterization.
- Define the RAOs for the media of interest.
- Identify general response actions for the media of concern.
- Identify remedial technologies that are applicable.
- Identify remedial alternatives that meet the RAOs.
- Conduct a detailed analysis of remedial alternatives based on National Oil and Hazardous Substances Contingency Plan (NCP) criteria.
- Conduct a comparative analysis of these remedial alternatives.

The terms “corrective measures” and “remedial actions” are terms used under the Resource Conservation and Recovery Act (RCRA) and CERCLA to refer to potential cleanup activities. The preferred alternative for the remaining coal ash and coal fines OUs will be presented in the Statement of Basis/Proposed Plan (SB/PP) to be submitted after approval of this FCMS/FS.

Supporting information includes the following: investigation data/data summary tables (Appendix A); contaminant fate and transport (Appendix B); human health risk assessment (HHRA) (Appendix C); ecological risk assessment (ERA) (Appendix D); principal threat source material (PTSM) evaluation (Appendix E); risk-based cleanup level calculations/preliminary remediation goals (Appendix F); natural resource injury evaluation checklist (Appendix G); and detailed cost estimates (Appendix H). All are pertinent to supporting the conclusions in this document.

1.2 Operable Unit Background

The SRS comprises an area of approximately 803 square kilometers (km^2) (310 square miles [mi^2]) located in Aiken, Barnwell, and Allendale counties about 32 km (20 miles [mi]) south of Aiken, South Carolina (Figure 1). The USDOE owns SRS while Savannah River Nuclear Services, LLC (SRNS) provides management and operating services for the environmental cleanup program. Since its creation in 1951, SRS has historically produced tritium, plutonium, and other special nuclear materials for national defense. SRS has also provided nuclear materials for the space program and for medical, industrial, and research efforts. Chemical and radioactive wastes are byproducts of the nuclear material production processes. Hazardous substances as defined by CERCLA and hazardous waste as defined by RCRA (40 Code of Federal Regulations [CFR] 261.20) (USEPA 2024) are currently present in the environment at SRS. On December 21, 1989, SRS was placed on the CERCLA National Priority List. In accordance with Section 120 of CERCLA, USDOE has entered into a Federal Facility Agreement (FFA) (FFA 1993) with SCDES and USEPA to coordinate cleanup activities at SRS under one comprehensive strategy that fulfills RCRA and CERCLA assessment, investigation, and response action requirements. The five OUs evaluated in this FCMS/FS are listed as RCRA/CERCLA units in Appendix C of the SRS FFA (FFA 1993).

Early infrastructure development of the SRS between 1951 and 1955 included the use of coal-fired powerhouses to generate steam and electricity. These powerhouses were located in each industrial/administrative area of the SRS. As a result of boiler operations, coal ash (coal combustion products) was produced as a waste product. The coal ash was either sluiced into a nearby ash basin or hauled to an ash pile. Associated coal pile runoff basins were constructed to receive surface water runoff from coal storage areas. Several SRS ash basins, coal pile runoff basins, and one ash pile have been remediated/certified closed with a final Record of Decision (ROD) in four SRS areas (A, D, P and R) (WSRC 2004, WSRC 2007, SRNS 2009, SRNS 2010, SRNS 2020a). The remedial actions for these OUs were implemented to meet regulatory requirements due primarily to elevated levels of arsenic (As) and naturally occurring radionuclides that result in unacceptable long-term risks to a future resident or industrial worker from direct exposure to the contaminated media. Beneficial reuse of ash material was not a component of the

remedial strategy for these previously closed OUs. The remaining coal ash and coal fines OUs evaluated in this FCMS/FS have been identified as candidates for beneficial reuse and are described below.

1.2.1 Operable Unit Description

The remaining coal ash and coal fines OUs are discussed in the following subsections based on physical description, habitats/ecological setting, hydrogeology, surface topography, and operable unit history.

Physical Description

A-Area Ash Pile

The AAP (788-A) is an inactive unit listed as a RCRA/CERCLA unit on Appendix C within the FFA (FFA 1993). The AAP is located in A Area in the northwest portion of SRS within the Upper Three Runs watershed (Figure 1). It is adjacent to an unnamed tributary that discharges into Tims Branch (Figures 2 and 3). The boundary of the AAP encompasses 0.65 hectares [ha] (1.60 acres [ac]) and is located south of the ACPRB (788-3A). The AAP was formed from the stockpiling of ash (bottom ash and fly ash) received from the A-Area coal-fired boiler house (784-A) between 1952 and 1978. The AAP ash and the additional ash outside the AAP boundary has an estimated total ash volume of 53,518 cubic meters [m^3] (70,000 cubic yards [yd^3]). During operation of the AAP, the pile was graded, the top leveled, and the north side (stream side) benched. Over the years, the banks of the unnamed tributary to Tims Branch were significantly scoured, and erosion threatened the stability of the ash pile until sheet piling and other erosion control measures were installed in the early 2000s. Though the erosion control measures appear to be sufficient, an annual slope stability assessment to monitor this area is performed to ensure that there is no immediate threat of collapse of the ash pile and/or migration into the adjacent tributary. The heavily vegetated side slopes help to prevent migration and slope failure. The depth to groundwater is ~ 37 m (~120 ft) below ground surface (bgs).

A-Area Coal Pile Runoff Basin

The ACPRB is located southeast of the A-Area boiler house (Figure 2). The ACPRB was constructed in 1978 and operated until closure of the boiler house in 2008. Runoff from the coal storage pile was collected/transported in ditches and underground pipes that discharged to the ACPRB. The basin is an unlined earthen surface impoundment surrounded by earthen berms. The ACPRB covers ~1.06 ha (2.62 ac) (Figure 4).

Elevations across the basin range from 105 to 108 m (344 to 355 ft) above mean sea level (amsl) (Figure 4). The ACPRB is inactive and receives water only via precipitation. The depth to groundwater in this area is ~ 37 m (~120 ft) bgs as determined by monitoring wells near the basin.

F-Area Ash Landfill Operable Unit

The F-Area Ash Landfill (FAL) (288-F) OU is an active Class II Landfill (SCDES Solid Waste Landfill Permit #025800-1601). The FAL OU is located in the Upper Three Runs watershed between F and H Areas (Figure 1). The FAL OU is listed as a RCRA/CERCLA unit in Appendix C of the FFA (FFA 1993). The FAL OU consists of an active landfill and the area outside the landfill boundary where ash deposits are known to exist (Figure 5). The FAL OU became operational in 1954 and received ash from the operation of the A-, F-, and H-Area powerhouses. The interior area of the FAL OU is ~ 2.8 ha (7.01 ac). The FAL OU is surrounded by a relatively congested industrial area and has engineered storm water controls in place. Depth to groundwater is ~ 21 to 24 m (70 to 80 ft) bgs.

The closure plan for the FAL OU includes a SCDES Class II cover system, with minimum 0.6 m (2 ft) soil cover (SRNS 2013a). SCDES clarified in a May 2022 meeting with the Core Team that the 288-F Class II Ash Landfill will remain a permitted operating landfill until beneficial reuse is initiated (SRNS 2022c).

H-Area Ash Basin Operable Unit

The HAB (288-H) OU is listed as a RCRA/CERCLA unit in Appendix C of the FFA (FFA 1993). The HAB OU is located in the Fourmile Branch watershed, downgradient of H Area (Figure 1).

The area of the HAB OU covers ~5.29 ha (13.06 ac). The HAB OU received ash via sluice of wet ash slurry from the H-Area powerhouse. The powerhouse operated from 1950 to 1990. All operating systems in the H-Area powerhouse have been shut down. In 1993 to 1994, ~76,455 m3 (100,000 yd3) of ash were removed from the basin and transported to the FAL (288-F) OU and F-Area Ash Basin (288-1F). Although the HAB OU is considered inactive since it no longer receives sluiced ash, the HAB OU is permitted as an "as-built" industrial wastewater facility (Permit #7291). HAB is currently receiving rainwater runoff from an above ground pipeline that accumulates in abatement pumps located behind the H-Area powerhouse (284-H) since 1981 and is considered an active unit in that regard. The rainwater runoff can be re-routed, as necessary, to support future remedial activities at the HAB OU.

The HAB OU includes wet ash/soils that have been frequently encountered beyond the boundary of the OU. The wet ash/soil coincide with a Carolina bay that is partially located within the southeastern boundary of the HAB OU (Figure 6). The depth to groundwater in this area is ~4.6 m (15 ft) bgs.

K-Area Ash Basin Operable Unit

The KAB (188-0K) OU is listed as a RCRA/CERCLA unit in Appendix C of the FFA (FFA 1993). The KAB OU is located southwest of the K-Reactor Complex and is in the Pen Branch watershed (Figure 1). The area of the basin is ~4.52 ha (11.16 ac) (Figure 7). The KAB OU received ash from the K-Area coal-fired powerhouse (184-K) via wet sluice. The powerhouse operated from 1951 to 1990. Although considered inactive since it no longer receives sluiced ash, the KAB is permitted as an "as-built" industrial wastewater facility (Permit #7293) and currently receives stormwater from the K-Area Ameresco Biomass Facility in the form of process blowdown water during the winter months. The wastewater permit has been active since 1981. The blowdown process can be re-routed, as necessary, to support future remedial activities at the KAB OU. The depth to groundwater in this area is ~ 16 m (53 ft) bgs.

L-Area Ash Basin Operable Unit

The LAB OU is an inactive ash basin listed as a RCRA/CERCLA unit in Appendix C of the FFA (FFA 1993). The LAB (188-L) OU is located northeast of the L-Reactor Complex (Figure 8). A small portion of the LAB OU is within the Steel Creek watershed, with the remainder in the Pen Branch watershed (Figure 1). The LAB OU received ash from the L-Area coal-fired powerhouse (184-L) via wet sluice. The powerhouse operated from 1951 to 1968. The area of the basin is ~7.13 ha (17.61 ac). The depth to groundwater in this area is estimated to be about 4.9 to 6.1 m (16 to 20 ft) bgs.

Habitats and Ecological Setting

In general, the remaining coal ash and coal fines OUs are located in upland areas that have undergone secondary succession since the cessation of operations. The current conditions are primarily represented by mature forested habitats, dominated with pine and/or hardwoods, associated shrub and scrub species, vines, and other various herbaceous species. The exception is the FAL OU. As discussed below, the FAL OU has an Operation and Maintenance (O&M) Plan for regular surface maintenance activities.

Other prominent distinctions of the remaining coal ash and coal fines OUs are discussed below.

A-Area Ash Pile

During operation of the AAP, the pile was graded, the top leveled, and the north side (stream side) benched. Currently, the AAP is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. The northeastern side of the AAP is adjacent to an unnamed tributary to Tims Branch. The banks of the adjacent tributary have been significantly scoured, and erosion threatened the stability of the ash pile until sheet piling and other erosion control measures were installed in the tributary in the early 2000s.

A-Area Coal Pile Runoff Basin

The ACPRB has undergone secondary succession and is primarily a mature upland pine/hardwood habitat (Figure 2). The ACPRB receives water only via precipitation. No appreciable aquatic habitat is present which is a different environmental condition from when the remedial investigation was performed. The RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment (BRA) (SRNS 2012) alluded to this future transformation with the collection of surface water from the basin, indicating that during the second of two sampling events, only a small area of ponded water, approximately 6.1 by 6.1 m (20 by 20 ft) wide, remained. The RFI/RI Report with BRA (SRNS 2012) stated that the elevated metals detected in surface water during the August 2009 (previous year sampling event) were likely the result of elevated turbidity. A field visit to the ACPRB was conducted on July 7, 2024, after an appreciable rain occurred several days prior. There was evidence of wet soils from two recent hog wallows but no surface water present, and no wetland vegetation was observed. Small volunteer pine trees were growing within the small depressional area indicating that this area, too, is transforming to a mature pine/hardwood habitat. Based on review of the topography, time-lapsed aerial photography, and confirmed by the field walk-down in July 2024, the area that may temporarily hold water at the ACPRB does not provide surface water and/or sediment exposure to aquatic or sediment-dwelling organisms due to the lack of adequate aquatic/wetland habitat within this successional forested ecosystem.

Threatened, endangered, and sensitive (TES) species surveys, including rare species, are conducted at the SRS for both flora and fauna. The description of the site is typically described based on flora observations to provide an overall description of the habitat that indicates what fauna that may reside/visit the area. Any TES species observed during the survey are noted, as well as habitats that may support TES or rare species, in describing the results of the TES surveys. A TES species survey was conducted in 1994 (USFS 1994a) in and around the ACPRB. Longleaf and loblolly pines predominated the area. Other noted vegetation were post and turkey oak, hackberry, a variety of shrubs (including wax myrtle and singed sumac), and various vines and hardwood species. Only one TES plant was found within a two-mile radius of the site, little bur-head, a wetland species, but it should not occur in the area of the ACPRB.

The habitats in the vicinity of the ACPRB generally do not meet the needs of most SRS TES species. The area is unlikely to support TES species with no specialized habitats (USFS 1994a).

F-Area Ash Landfill Operable Unit

The FAL OU is surrounded by an earthen dike wall and has an overflow conduit that is located within the sedimentation basin, also inside the earthen dike. The FAL OU has an O&M Plan for regular maintenance and is maintained by mowing to prevent woody plants from becoming established. The settling basin associated with the FAL OU is inspected and maintained to allow for unobstructed discharge and to survey for erosion, washouts, or other conditions that prevent proper operation (SRNS 2013b).

A TES species survey was conducted on ~607 ha (1500 ac) within/surrounding the F-Area Burial Ground Complex and waste units within the expanded area including the FAL OU in 1994 (USFS 1994b). Field surveys found very little in the way of specialized habitats that may support TES species. While there were few TES species identified, they were associated with Carolina bays or mesic valley conditions associated with floodplains or marginal wetlands located within/near wet areas. The area within and around the FAL OU is a highly modified upland habitat. TES species are unlikely because of disturbance and current/historic uses.

H-Area Ash Basin Operable Unit

The HAB OU has undergone secondary succession since operations at the basin have ceased. The HAB OU is currently heavily vegetated with mature pines, hardwoods, and dense undergrowth. The habitats primarily support terrestrial receptors. Wet ash/soils have been observed at the southeastern side of the basin based on previous field visits. The wet conditions are primarily located/associated with ash deposits outside the basin berm where ash deposits align with the location of the Carolina bay that is partially located within the ash deposits/basin boundary. This portion of the HAB OU was partially constructed on a Carolina bay (Figure 6). Carolina bays are shallow elliptical depressions that vary in size, are oriented northwest to southeast, are commonly 0.6 to 1.2 m (2 to 4 ft) deep and are found on the southeastern Atlantic coastal plain area. Their widespread extent was unknown until the use of aerial photography in the 1930s at Myrtle Beach,

South Carolina. Carolina bays have high levels of organic matter and often have thick layers of black humus and peat including decayed vegetation and the presence of illite and kaolinite clays in the depression bottom that serves as a clay lens. Peat and organic soil layers can vary in thickness to over 3.7 m (12 ft) depending upon the age of the bay. The bays tend to have high amounts of organic carbon providing high levels of organic acids, high cation exchange capacity, low hydraulic conductivity, and low base saturation. Carolina bays, in general, have a history of disturbance. Ditching and draining was a common practice, primarily to support cultivation. Some bays on the SRS have been restored to pre-disturbance conditions.

K-Area Ash Basin Operable Unit

The KAB OU has undergone secondary succession since operations at the basin have ceased. The KAB OU is currently heavily vegetated with mature pines, hardwoods with dense undergrowth. No standing water has been observed during multiple field visits to the basin.

A TES species survey was conducted for the K-Area Bingham Pump Outage Pits that also included the footprint of the KAB OU encompassing portions of three timber compartments. Loblolly pine predominates that area south of K Area. Other canopy species include sweet gum, red maple, and persimmon. Slash pine dominates areas west of K Area. A small population of Nestronia (*Nestronia umbellule*) (rare/sensitive species) was observed in the southwest portion of the area within a stand of black oak, hickory, and scarlet oak. This species is typically found within upland mixed hardwood and wetland mixed hardwoods habitat. No specialized habitats were identified that would support TES species within/near the KAB OU. In terms of fauna, the bald eagle likely uses the survey area at least as a transient area since a bald eagle nest is located southeast of the survey area on Pen Branch providing a nesting site about 1 mile away (USFS, 1994c).

L-Area Ash Basin Operable Unit

The LAB OU has undergone secondary succession since operations have ceased at the basin and is currently heavily vegetated with mature pines, hardwoods, and a dense undergrowth. The habitats primarily support terrestrial receptors. Observations of wet conditions have been noted

based on previous field visits, with observations of standing water from three previous field visits to the LAB OU.

Groundwater Hydrogeology

The unconsolidated marine and fluvial sediments of the Atlantic coastal plain underlying SRS are a variably stratified, heterogeneous sequence of sand, clay, and gravel layers, with some limey sections in the southern half of the site. In terms of hydrostratigraphy, the uppermost sediments compose the Floridan Aquifer System (Figure 9). The Floridan Aquifer System at the FAL OU, HAB OU, KAB OU, and LAB OU consists of, in ascending order, the Gordon Aquifer (GA), the Gordon Confining Unit (GCU), and the Upper Three Runs Aquifer (UTRA). In A/M Area, where the AAP and ACPRB OU is located, the GA is referred to as the Lost Lake Aquifer, and the UTRA is referred to as the M-Area Aquifer Zone (MAAZ). Any groundwater contaminant plume from ash would be located in the UTRA, or the MAAZ, of the Floridan Aquifer System. The Floridan Aquifer System is separated from lower aquifer units by the Crouch Branch Confining Unit, which is a competent aquitard.

The UTRA extends from the GCU to the water table. The thickness of this aquifer is typically 30.5 to 45.7 m (100 to 150 ft) thick and is informally divided into three aquifer zones: the Lower Aquifer Zone and Upper Aquifer Zone (UAZ), which are separated by the Tan Clay Confining Zone (TCCZ), and the Middle Aquifer Zone, which is a sandy layer within the TCCZ. In A/M Area, the MAAZ is about 3.0 to 6.1 m (10 to 20 ft) thick.

The TCCZ is made up of sediments from the Dry Branch Formation and contains tan to orange clay and sandy clay interbedded with clayey sand and sand. The UAZ is the upper portion of the Dry Branch Formation with sediments that are moderately to poorly sorted, coarse to medium grained silty sands, silty clay layers and some pebble zones. The A/AA horizons consist of all sediments above the Dry Branch Formation, including the Tobacco Road Formation and the "upland unit." These horizons are typically unsaturated and make up the vadose zone. The "upland unit" sediments are commonly very dense and clayey and often contain gravely sand. The topographic surface bounds the top of the A/AA creating a widely variable thickness across the

SRS. It is deeply incised by stream channels such as Upper Three Runs, Fourmile Branch, Pen Branch and/or Steel Creek and major tributaries associated with these mainstream systems.

Surface Topography

Site-wide, ground elevations at SRS range from ~21 m (70 ft) amsl at the mouth of Lower Three Runs Creek to over 122 m (400 ft) amsl on the Aiken Plateau (WSRC 1995).

A-Area Ash Pile

Within the AAP, the topography ranges from ~99 to 101 m (325 to 330 ft) amsl. The northeastern boundary of the AAP is immediately adjacent to a small unnamed tributary to Tims Branch. The tributary stream channel has been significantly eroded; the base of the streambed adjacent to the AAP is about 90 m (295 ft) amsl. During operation of the AAP, the pile was graded, the top leveled, and the north side (stream side) benched. The elevation at the top of the pile is ~105 m (345 ft) amsl (4.6 to 6.1 m [15 to 20 ft] above grade).

Surface water in the vicinity of the AAP drains to the north-northeast via overland flow toward the unnamed tributary of Tims Branch, to Tims Branch, and to Upper Three Runs Creek (SRNS 2012a).

A-Area Coal Pile Runoff Basin

Elevations across the ACPRB range from 105 to 108 m (344 to 355 ft) amsl. Surface water in the area drains to the east-southeast via overland flow or along small intermittent stream channels to Tims Branch, a tributary to Upper Three Runs Creek (SRNS 2012a).

F-Area Ash Landfill Operable Unit

Surface elevations across the FAL OU range from 85 to 95 m (278 to 311 ft) amsl. Surface water in the area drains to the north-northwest toward Upper Three Runs Creek along surface gradients and intermittent stream channels.

H-Area Ash Basin Operable Unit

Elevations across the HAB OU range from 85 to 90 m (278 to 295 ft) amsl. The land surface slopes toward Fourmile Branch. A constructed ditch on the southern side of the basin channels water from the basin to the south-east toward a small permanently pooled water body that flows toward a small tributary of Fourmile Branch at the northwest corner of H Area.

K-Area Ash Basin Operable Unit

Elevations across the KAB OU range from 75 to 80 m (246 to 262 ft) amsl with a gentle slope toward Indian Grave Branch. The KAB OU is not located near surface water conveyances that would facilitate surface water movement.

L-Area Ash Basin Operable Unit

Elevations across the LAB OU range from 75 to 80 m (246 to 262 ft) amsl. A small portion of the LAB OU is located within the Steel Creek watershed, with the remainder in the Pen Branch watershed. In general, the surface water from the LAB OU would flow toward Pen Branch.

Operable Unit History

With the exception of the AAP and ACPRB OU, no previous RCRA/CERCLA regulatory actions have been implemented for the remaining coal ash and coal fines OUs considered for beneficial reuse. The AAP and ACPRB OU was investigated via the Remedial Investigation/Feasibility Study (RI/FS) process in 2008 and documented in the combined *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit* (SRNS 2012a). A Revision 1.1 Redline SB/PP (SRNS 2014a) was submitted in March 2014 identifying the preferred remedial action for consolidation of AAP into the ACPRB with a soil cover, land use controls (LUCs), and groundwater monitoring. A preliminary design for excavation of the AAP was prepared as part of the SB/PP development in 2014. Finalization and regulatory approval of the SB/PP and preparation of a ROD were placed on hold due to the uncertainty

associated with the proposed USEPA coal combustion residuals (CCRs) regulations being applied to this OU as applicable or relevant and appropriate requirements (ARARs). In 2020, additional fieldwork was performed for the AAP and ACPRB OU as part of the ash consolidation strategy development (SRNS 2020b) to determine and estimate the extent of ash along transects outside the boundary of the ash pile.

In 2022, the USDOE proposed a wholistic remedial approach to address the remaining coal ash and coal fines OUs at the SRS, including the AAP and ACPRB OU, that includes future beneficial reuse of the ash material as fill material or a concrete additive rather than a waste material that requires excavation and disposal or containment by an engineered cover system.

The proposed regulatory strategy was presented at a Core Team meeting held on April 19, 2022, with a follow-up meeting held on May 23, 2022. As a result of these meetings, SRS submitted the *Preferred Remedial Action and Regulatory Strategy for Remaining Savannah River Site's Coal Ash and Coal Fines Operable Units (U)* (SRNS 2022b) in July 2022 to the USEPA and SCDES for regulatory review and approval. SCDES provided comments on the strategy letter, and SRS provided responses to the comments on September 15, 2022. The USEPA and SCDES approved the implementation and administrative strategy for the remaining coal ash and coal fines OUs on August 11, and September 22, 2022, respectively.

Data Evaluation

The AAP and ACPRB OU was investigated via the RI/FS process in 2008. The investigation characterization of the AAP was conducted in 2009 and included ash and soil samples from five borehole locations. Ash samples were collected from 0 to 0.3 m (0 to 1 ft), 0.3 to 1.2 m (1 to 4 ft), and 2.4 to 3.0 m (8 to 10 ft) bgs and directly above the ash/soil contact. The soil intervals (native material below the ash) were collected from the 0 to 0.3 m (0 to 1 ft), 0.3 to 1.2 m (1 to 4 ft), 1.8 to 2.4 m (6 to 8 ft), and 3.0 to 3.7 m (10 to 12 ft) bgs. In total 21 ash and 18 soil samples were collected from the AAP.

Characterization of the ACPRB include sampling of sediment/coal fines, soil, surface water, and groundwater. Four locations within the basin were sampled at six depth intervals for a total depth

of 6.1 m (20 ft) bgs. In addition, soil was collected from one sample location adjacent to the basin at four depth intervals to a total depth of 3.7 m (12 ft) bgs. In total, 29 sediment/coal fines/soil samples were collected. Ash/soil samples were collected at both units and analyzed for pH, alkalinity, target compound list (TCL) constituents (including volatile organic compounds, semi-volatile organic compounds], pesticides, and poly-chlorinated biphenyls), target analyte list (TAL) inorganics (including metals, mercury, and cyanide), sulfate, phosphate, gross alpha, non-volatile beta, gamma spectroscopy, alpha spectroscopy (uranium and thorium isotopes), radium-226, and radium-228. The ash-related contaminants identified for remedial action (i.e., As and naturally occurring radionuclides) are consistent with other ash waste units. The complete data evaluation and results are documented in the 2012 combined document (SRNS 2012a). The evaluation is complete and additional data collection to support this FCMS/FS was not needed.

Data for the HAB, KAB, and LAB OUs were obtained from sampling that was conducted according to the *Sampling and Analysis Plan for Pre-Characterization of the A-Area Ash Pile (188-0A), F-Area Ash Landfill (288-0F), H-Area Ash Basin (288-0H), L-Area Ash Basin (188-0L), K-Area Ash Basin (188-0K), and D Ash Overflow* that was developed in 2020 (SRNS 2020b). As part of the ash consolidation strategy development, three ash/soil samples were collected from the HAB, KAB, and LAB OUs in 2020 to compare the results to other remediated OUs with similar ash-related contaminants (i.e., As and naturally occurring radionuclides) and to analyze the material for geophysical parameters. In addition, the extent of ash outside the basin berms was estimated by visual field observations (presence/absence) from multiple transects extending from the boundary of the units where appreciable ash was known/suspected outside the unit boundary (Figure 3 and Figures 6-8) as discussed in Section 1.2.2 (SRNS 2020b). Samples were collected in each basin from the 0- to 0.3-m (0- to 1-ft) surface interval and analyzed for constituents with the potential to occur in the ash units, (e.g., TAL/TCL, gross alpha, nonvolatile beta, and radionuclides). These data were combined into one dataset consisting of nine sample results (three locations per basin) and processed in accordance with the protocols in the Environmental Compliance and Area Completion Projects (EC&ACP) Regulatory Document Handbook (June 2023). The ProUCL software package (USEPA 2022) was used to calculate the 95% upper confidence limit (UCL) on the arithmetic mean. Non-detected constituent concentrations were

processed in accordance with the ProUCL User's Guide (USEPA 2022). The data are presented in Appendix A.

Table 1 demonstrates that concentrations of As and naturally occurring radionuclides (along with corresponding human health risk levels of these constituents) for the HAB, KAB, and LAB OUs are consistent with other ash waste unit risk evaluations that have been previously performed, including OUs that have completed a formal BRA process such as the AAP and ACPRB OU.

For the FAL OU, a total of eight samples were collected and analyzed for Toxic Characteristic Leaching Procedure metals and total metals in 2012. The results were documented in the *Waste Characterization Report for Savannah River Site Ash Outside 288-F Landfill* and submitted to SCDES (SRNS 2012b). With the exception of As, no samples were above residential risk screening levels and/or SRS background levels. Arsenic concentrations were consistent with other ash containing units. Radionuclide results are not available but are expected to be consistent with naturally occurring radionuclides present at similar ash basins (i.e., HAB, KAB, and LAB OUs). Based on the As results and similarity with the other ash OUs, the Core Team agreed with the use of analogous site data from the HAB, KAB, and LAB OUs combined into one dataset for use at the FAL OU, and additional data collection to support a remedial decision for the FAL OU was not needed.

The data comparison demonstrates that the data for the remaining coal ash and coal pile OUs are consistent and usable for the purposes of remedial decision-making as agreed to by the Core Team during the November 2, 2023, Scoping Meeting for the Focused CMS/FS.

1.2.2 Nature and Extent of Contamination

The estimate of the extent of ash is based on a review of historic topographic data, current light detection and ranging (LiDAR) data, historic photographs, and unit records. For units with known/suspected appreciable ash outside the unit boundary (AAP, FAL, HAB, KAB, and LAB), a field walkdown was conducted. Based on the walkdown, transects were established with the purpose of estimating the extent of ash based on visual observation. The transect sampling was conducted by taking step-outs along the transects radiating from the edge of the ash unit boundary

where ash was either known to exist or was suspected. The transect sampling was based on ash/soil borings taken along the transects advanced vertically up to a maximum depth of 30.5 cm (12 in.). Additional boring locations followed, as needed, with 3-m (10-ft) step-outs. Longer transects included 30-m (100-ft) step-out intervals. The step-outs were employed until an ash-free location was located or an impedance was encountered (road, etc.). Upon finding an ash-free location, the step-out was set at one-half the length of the previous step to bound the ash. Transect sampling began May 13, 2020, and was completed June 8, 2020. The sampling was described in the *Sampling and Analysis Plan for Pre-Characterization of the A-Area Ash Pile (188-0A), F-Area Ash Landfill (288-0F), H-Area Ash Basin (288-0H), L-Area Ash Basin (188-0L), K- Area Ash Basin (188-0K), and D Ash Overflow* (SRNS 2020b).

Depths of ash were estimated from unit records, if available, and current LiDAR data compared to historic topography data. The depth estimates support the volume estimates provided in this CMS/FS.

A-Area Ash Pile and A-Area Coal Pile Runoff Basin Operable Unit

The area of ash within the boundary of the AAP is approximately (~) 0.6 ha (1.6 ac). The ash within the AAP extends northward towards the edge of an unnamed tributary to Tims Branch (Figures 2-3). The total area of ash, including ash outside the boundary, is ~1.1 ha (2.55 ac). The total volume of ash is ~53,518 m^3 (70,000 yd^3). The depth of ash is variable with the average depth of ~5 m (17 ft). Grade level at the AAP ranges from 99 to 101 meters [m] (325 to 330 feet [ft]) above mean sea level (amsl), and the elevation at the top of the pile is ~ 105 m (345 ft) amsl (4.6 to 6.1 m [15 to 20 ft] above grade).

The area of coal fines within the ACPRB is ~1.06 ha (2.62 ac) (Figure 4). The approximate total volume of coal fines is 7,646 m3 (10,000 yd3). The average depth of coal fines within the ACPRB is ~0.7 m (2.4 ft).

F-Area Landfill Operable Unit

The FAL OU ash deposition area extends beyond the boundary of the ash landfill in all directions (Figure 5). The area of ash within the landfill is ~2.8 ha (7.01 ac). As of August 2023, the volume of ash within the FAL OU was calculated to be ~151,457 m^3 (198,099 yd^3). Additional ash outside of the landfill is estimated to have an area of 4.6 ha (11.47 ac) and a volume of 11,743 m^3 (15,360 yd^3). The total area of ash is ~7.48 ha (18.48 ac) and the total volume of ash at the FAL OU is ~163,201 m^3 (213,459 yd^3). The depth of ash is variable with an average depth of ~9.8 m (32 ft).

H-, K-, and L-Area Ash Basin Operable Units

The HAB OU ash deposition area extends outside of the ash basin boundary (Figure 6). The area of ash within the HAB OU is ~5.29 ha (13.06 ac). The volume of ash within the boundary is ~84,944 m^3 (111,103 yd^3). Additional ash outside of the basin boundary is estimated to have an area of ~7.45 ha (18.40 ac) and a volume of 113,161 m^3 (148,009 yd^3). The depth of ash is variable with an average depth of ~3.6 m (12 ft). The total area of ash within and outside of the basin boundary is ~12.73 ha (31.46 ac). The total volume of ash inside and outside the basin boundary is ~198,105 m^3 (259,112 yd^3).

The area of ash within the KAB OU is ~4.52 ha (11.16 ac). The volume of ash within the boundary is ~194,627 m^3 (254,563 yd^3). The KAB OU ash area extends beyond the ash basin boundary predominantly in the northwest and minimally southeast of the unit boundary (Figure 7). Additional ash outside of the basin boundary is estimated to be 1.54 ha (3.81 ac) with a volume of 13,734 m^3 (17,964 yd^3). The total area of ash inside and outside the basin is ~6.06 ha (14.97 ac). The total volume of ash inside and outside the basin boundary is ~208,362 m^3 (272,527 yd^3). The depth of ash is variable with an average depth of ~4.5 m (15 ft).

The LAB OU ash deposition area extends outside of the ash basin boundary in the southeast direction (Figure 8). The area of ash within the boundary is ~7.13 ha (17.61 ac) with a volume of ash within the boundary of ~233,189 m^3 (305,000 yd^3). Additional ash outside of the basin boundary is estimated to have an area of 0.68 ha (1.67 ac) and a volume of ~13,781 m^3 (18,026 yd^3). The total area of ash within and outside of the basin boundary is ~7.80 ha (19.28 ac). The

total volume of ash inside and outside the basin boundary is ~246,971 m^3 (323,026 yd^3). The depth of ash is variable with an average depth of ~3.3 m (11 ft).

1.2.3 Conceptual Site Model

The conceptual site model (CSM) is an objective framework for assessing data pertinent to the investigation. The CSM identifies and evaluates suspected sources of contamination, contaminant release mechanisms, potentially affected media (secondary sources of contamination), potential exposure pathways, and potential human and ecological receptors.

Exposure pathways describe the course a chemical or physical agent takes from the source to the exposed receptor. The following five (5) components make up an exposure pathway:

- Source (facility operations, spill, etc.)
- Exposure media (soil, groundwater, etc.)
- Exposure point (drinking water well, etc.)
- Exposure route (external radiation, ingestion, dermal contact, inhalation, etc.)
- 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 five components are present to permit potential exposure of a receptor to a source of contamination. Exposure analysis is conceptually 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.

The most likely receptor scenarios include the human receptor scenarios (hypothetical residential and industrial worker). The primary exposure pathways for evaluation relative to human receptors include:

- Exposure to surface media 0 to 0.3 m (0 to 1 ft) via incidental ingestion, dermal contact, inhalation of windblown dust, inhalation of volatile constituents, and external exposure from radionuclides.

A comparison of exposure assumptions for the human health exposure scenarios is provided below:

Potential Receptor	Years	Days/Year	Hours/Day	Exposure Hours
Hypothetical Resident	26	350	24	218,400
Industrial Worker	25	250	8	50,000

Source: SRNS 2023

From an ecological risk perspective, the habitats for the remaining coal ash and coal fines OUs primarily supports terrestrial receptors. The media of concern are the surficial ash 0 to 0.3 m (0 to 1 ft). Surface water and sediment associated with the ACPRB at one time provided a potential aquatic/semi-aquatic habitat, however that marginal aquatic/semi-aquatic habitat has undergone secondary succession and is now a forested ecosystem with no aquatic/semi-aquatic habitat. Terrestrial receptors include earthworm (soil invertebrate), deer mouse (mammalian omnivore), Montane shrew (insectivorous mammal), American robin (insectivorous/omnivorous/herbivorous bird) and American kestrel (carnivorous/insectivorous bird, avian top predator), mountain cottontail (herbivorous mammal), and gray fox (carnivorous mammal, top predator).

Leaching of contaminants from the contaminated media to groundwater constitutes a secondary contaminant release mechanism. The potential to leach to groundwater is evaluated in the contaminant migration (CM) analysis (Appendix B).

The preliminary CSMs for the remaining coal ash and coal fines OUs are presented in Figures 10-15.

1.2.4 Baseline Risk Assessment

1.2.4.1 Summary of Contaminant Fate and Transport

Contaminant migration analyses for the AAP and ACPRB OU were completed in the approved RCRA RFI/RI Work Plan and RFI/RI/BRA/CMS/FS for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) OU (SRNS 2012a). There were no CM refined constituents of concern (RCOCs) identified for either the AAP or the ACPRB. A CM analysis was performed using VZCOMML© (V.4.0)[2] for the FAL, HAB, KAB, and LAB OUs. There were no RCOCs identified for the KAB OU or the FAL OU. The CM analysis identified CM RCOCs in the vadose zone for the HAB OU (barium [Ba], uranium-233/234 [U-233/234], uranium-235 [U-235], uranium-238 [U-238]) and the LAB OU (Ba), with the potential to migrate to groundwater and exceed groundwater action levels within 1,000 years (Appendix B). Table 2 summarizes the Tier I and Tier II Screening Results. The mean travel times calculated for the HAB OU CM RCOCs were 402 years for Ba and 845 years for the uranium radioisotopes. The mean travel time calculated for Ba at the LAB OU was 638 years. CM cleanup levels for identified CM RCOCs were determined using the highest Tier II soil screening level calculated for each OU.

1.2.4.2 Summary of the Human Health Risk Assessment

The HHRA is presented in Appendix C of this document. The results indicate that the potential risk to both human receptor scenarios (residential and industrial worker) evaluated in the HHRA exceeds 1E-06 or a hazard index (HI) = 1 for exposure to As and coal-related radionuclides (potassium-40 [K-40], thorium-232 [Th-232], and U-238). The risk estimates for each of the RCOCs for each receptor scenario are summarized below. RCOCs are defined as constituents of concern (COCs) that have undergone an uncertainty evaluation and require a remedial action.

1.2.4.2.1 A-Area Ash Pile and A-Area Coal Pile Runoff Basin Operable Unit

As stated above in Section 1.2.2, the AAP and ACPRB OU has been previously investigated under the RI/FS process in 2008 and documented in a RCRA RFI/RI Workplan and

[2] Vadose Zone Contaminant Migration Multi-Layered Model (VZCOMML©) Version 4.0, Copyright TXu 1-663-361, 2009, Savannah River Nuclear Services, LLC.

RFI/RI/BRA/CMS/FS Report (SRNS 2012a). The complete HHRA is provided in Appendix E of the referenced report. The conclusions of the HHRA are outlined below.

Results from the AAP assessment identified one metal (As) and three radionuclides (K-40, Radium-226 [Ra-226], and U-238) as human health (HH) RCOCs in the 0 to 0.3 m (0 to 1 ft) surface ash/soil interval. Ra-226 is a daughter product of the U-238 decay series and will be managed under the cleanup level established for the entire decay series.

Residential scenario, 0 to 0.3 m (0 to 1 ft) ash/soil interval: HH RCOCs include As (risk = 5.4E-05), K-40 (risk = 1.3E-04), Ra-226 (risk = 1.8E-04), and U-238 (risk = 2.8E-06); the total cumulative risk (TCR) is 3.7E-04.

Industrial worker scenario, 0 to 0.3 m (0 to 1 ft) ash/soil interval: HH RCOCs include As (risk = 1.3E-05), K-40 (risk = 7.3E-04), Ra-226 (risk = 1.0E-04), and U-238 (risk = 1.4E-06); the TCR is 1.9E-04.

Results from the ACPRB assessment identified one metal (As) as a HH RCOC in the 0 to 0.3 m (0 to 1 ft) surface ash/coal fines interval.

Residential scenario, 0 to 0.3 m (0 to 1 ft) surface ash/coal fines interval: HH RCOCs include As (risk = 9.4E-05).

Industrial worker scenario, 0 to 0.3 m (0 to 1 ft) surface ash/coal fines interval: HH RCOCs include As (risk = 2.3E-05).

1.2.4.2.2 F Area Landfill, H Area Ash Basin, K Area Ash Basin, and L Area Ash Basin Operable Units

As agreed to by the Core Team (USEPA, SCDES, and USDOE) at the November 2023 scoping meeting, the data from the HAB, KAB, and LAB OUs was combined into one dataset for data processing. Table 1 demonstrates that concentrations of As and naturally occurring radionuclides (and corresponding risk levels of these constituents) for the HAB, KAB, and LAB OUs are consistent with other ash waste unit risk evaluations that have been performed in the past including OUs that have gone through a formal BRA process such as the AAP and ACPRB OU.

Based on the consistency between ash units, it was determined that concentrations of ash-related constituents at the FAL OU were consistent with similar characterized ash waste units. As agreed to by the Core Team at the November 2023 scoping meeting, the combined dataset from the HAB, KAB, and LAB OUs will also be applied to the FAL OU as well.

Results from the FAL, HAB, KAB, and LAB OUs HHRA identified one metal (As) and three radionuclides (K-40, Th-232, and U-238) as HH RCOCs for the 0 to 0.3 m (0 to 1 ft) surface ash/soil interval as follows:

Residential scenario for the 0 to 0.3 m (0 to 1 ft) surface ash/soil interval: HH RCOCs include As (risk = 5.6E-05, hazard quotient [HQ] = 1.1), K-40 (risk = 7.8E-05), Th-232 (risk = 3.5E-04), and U-238 (risk = 4.4E-04); the HI is 2.0 and the TCR is 9.8E-04.

Industrial worker scenario for the 0 to 0.3 m (0 to 1 ft) surface ash/soil interval: HH RCOCs include As (risk = 1.3E-05), K-40 (risk = 5.1E-05), Th-232 (risk = 2.2E-04), and U-238 (risk = 2.8E-04); the TCR is 5.7E-04.

1.2.4.3 Summary of the Ecological Risk Assessment

The ERA is presented in Appendix D of this document. No RCOCs were identified that require a remedial action.

Site-specific ecological/biological studies have been conducted on various ash units at the SRS, primarily associated with ash depositional areas in sensitive environments such as Carolina bays (i.e., Wetland Area at Dunbarton Bay (WADB)) or within floodplain habitat (i.e., D-Area Ash Basin Wetlands (DABW)). Despite elevated concentrations of trace elements within soil and/or biota associated with various ash OUs on the SRS, overall ecological site-specific studies of SRS ash depositional areas demonstrate that ash exposure within historically contaminated sites has limited impact on community-level metrics. Instead, the community data indicate species richness, diversity, and composition of small vertebrates are similar between contaminated and reference sites. The remaining coal ash and coal fines OUs offer similar habitat to surrounding areas that have become more integrated within the natural landscape. These recolonized/recovered

areas appear healthy and diverse, and it is reasonable to conclude that from an ecological perspective, the remaining coal ash and coal fines OUs offer similar habitat to surrounding areas. This can be expanded to include ash piles, basins, and the coal pile runoff basin that become integrated within the natural landscape over time.

1.2.4.4 Summary of the Principal Threat Source Material Evaluation

The PTSM evaluation is presented in Appendix E. No PTSM RCOCs were identified for the surface ash/soil media at any of the remaining coal ash and coal fines OUs. Results of the PTSM evaluation for soil at the AAP indicate that the HI is 1.6 and the cumulative risk is 3.5E-05. Results of the PTSM evaluation for soil at the ACPRB indicate that the HI is 2.0 and the cumulative risk is 1.4E-04. Results of the PTSM evaluation for soil at the FAL, HAB, KAB, and LAB OUs indicate that the HI is 0.3 and the cumulative risk is 8.1E-04.

1.2.4.5 Conclusion

The remaining coal ash and coal fines OUs were investigated to determine the nature and extent of contamination; the risk to the resident, industrial worker, and the environment; the presence of PTSM; and if there are constituents that are a CM concern. Results of the 2012 BRA for the AAP and ACPRB OU were carried through for the HHRA, ERA, PTSM evaluation, and CM analysis. The FAL, HAB, KAB, and LAB OUs were evaluated based on the consolidated 2020 samples and were screened against the appropriate regulatory thresholds and protocols to identify RCOCs that warrant further consideration for remedial action. Results of the evaluations for the remaining coal ash and coal fines OUs indicate that there are no ecological or PTSM RCOCs. CM RCOCs were identified for the HAB OU (Ba, U-233/234, U-235, U-238) and the LAB OU (Ba). The potential risk to both human receptor scenarios (residential and industrial worker) evaluated in the HHRA exceeds 1E-06 or HI = 1 for exposure to As and coal-related radionuclides (K-40, Th-232, Ra-226, and U-238). A summary of the RCOCs is provided in Table 3. Based on these conclusions, the preliminary CSMs have been revised and are now presented as refined CSMs as shown in Figures 16-21.

1.2.5 Problems Warranting Action

The problems warranting remedial action for the five remaining coal ash and coal fines OUs are discussed below. The refined CSMs for the remaining coal ash and coal fines OUs that support the problems warranting action are presented in Figures 16 through 21.

A-Area Ash Pile and A-Area Coal Pile Runoff Basin Operable Unit

Industrial worker and future resident scenario HH RCOCs identified for the AAP include As and naturally occurring radionuclides. Industrial worker and future resident scenario HH RCOCs identified for the ACPRB include As. There were no PTSM, CM, or ecological RCOCs identified for the AAP and ACPRB OU.

The following problems warranting action exist for the AAP and ACPRB OU:

- AAP: As and naturally occurring radionuclides (K-40, Ra-226, U-238) are present in 0.0 to 0.3 m (0 to 1 ft) surface ash/soil that pose an unacceptable risk to the future resident (TCR = 3.7E-04) and industrial worker (TCR = 1.9E-04).
- ACPRB: As is present in the 0.0 to 0.3 m (0 to 1 ft) surface ash/soil that presents an unacceptable risk to the future resident (TCR = 9.4E-05) and industrial worker (TCR = 2.3E-05).

F-Area Landfill Operable Unit

Industrial worker and future resident scenario HH RCOCs identified for the FAL OU include As and naturally occurring radionuclides. There were no CM, PTSM, or ecological RCOCs identified for the FAL OU. The following problem warranting action exists for the FAL OU:

- Arsenic and naturally occurring rads are present in the 0.0 to 0.3 m (0 to 1 ft) surface ash/soils that pose an unacceptable risk to the future resident and industrial worker.

H-, K-, and L-Area Ash Basin Operable Units

Industrial worker and future resident scenario HH RCOCs identified for the H-, K-, and L-Area Ash Basin OUs include As and naturally occurring radionuclides. The CM RCOCs identified for the HAB OU were Ba, U-233/234, U-235, and U-238. Ba was identified as a CM RCOC for the LAB OU. There were no PTSM or ecological RCOCs identified for the HAB, KAB, LAB OUs. The following problems warranting action exist for the HAB, KAB, and LAB OUs:

- Arsenic and naturally occurring radionuclides are present in the 0.0 to 0.3 m (0 to 1 ft) ash/soil interval that pose an unacceptable risk to the future resident and industrial worker for the HAB, KAB, and LAB OUs.
- Ba is present in the vadose zone with the potential to migrate to groundwater and exceed groundwater action levels within 1,000 years for the HAB OU and LAB OU.
- U-233/234, U-235, and U-238 are present in the vadose zone with the potential to migrate to groundwater and exceed groundwater action levels within 1,000 years for the HAB OU.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section summarizes the technology screening for the remaining coal ash and coal fines OUs and the unit-specific RAOs for ash/soil contamination in relation to the PRGs which have been developed. Identified technologies are screened using the NCP criteria: effectiveness, implementability, and cost. Technologies that pass this screening are retained and carried forward into the development of remedial action alternatives.

2.1 Remedial Action Objectives

RAOs are site-specific goals defining the extent of cleanup required to achieve protection of human health and the environment. RAOs specify the RCOCs, media of concern, protected receptors, potential pathways, ARARs, and target cleanup goals. RAOs are based on the nature and extent of contamination, threatened resources, and the potential for human and environmental exposure. The RAOs provide a framework for developing remedial alternatives in the FCMS/FS and are identified as follows:

- For all remaining coal ash and coal fines OUs, prevent human exposure to contaminants present in the surface ash/soil that present a risk to the future resident and industrial worker greater than 1E-06 risk threshold or background levels.
- For the HAB OU and LAB OU, protect groundwater resources from migration of contaminants in unit ash/soil that would impact the groundwater above groundwater protection standards.

2.1.1 Allowable Exposure Based on Risk Assessment

Section 121(d) of CERCLA (CERCLA 1980), as amended by Superfund Amendments and Reauthorization Act (SARA), (SARA 1986), requires that remedial action comply with requirements or standards set forth under Federal and State environmental laws. These are considered ARARs and include action-specific, location-specific, and chemical-specific requirements. SARA requires that the remedial action for a site meet all ARARs unless a waiver is invoked for one of the following reasons:

1. The remedial action is an interim measure where potential final actions will attain the ARAR upon completion.
2. Compliance will result in greater risk to human health and the environment than other options.
3. Compliance is technically impracticable.
4. The remedial action will attain the equivalent of an ARAR.
5. The State has not consistently applied the requirement in similar circumstances.
6. SARA Section 121(e) exempts any federal, on-site remedial action from administrative requirements for Federal, State, and/or local permits. However, on-site actions still must comply with the substantive, technical aspects of these requirements.

Potential ARARs are classified as either applicable or relevant and appropriate. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that do not specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, but nonetheless are well suited to the particular site.

In general, relevant and appropriate requirements involve comparing a number of site-specific factors with those addressed in the statutory or regulatory requirement. Site-specific factors include the characteristics of a remedial action, hazardous substances present at the site, or physical circumstances of the site. In some cases, a requirement can be relevant but not appropriate based on site-specific circumstances and thus may not be selected as an ARAR for the site. Therefore, it is not an ARAR for the site. There is additional flexibility in the determination of relevant and appropriate requirements. It is possible for only part of a requirement to be considered relevant and appropriate in a given case. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.

In addition to ARARs, many Federal and State environmental and public health programs include criteria, guidance, and proposed standards that are not legally binding but provide useful

approaches or recommendations. These "To-be-considered" (TBC) requirements are non-promulgated advisories or guidance issued by Federal or State government that are not legally binding and do not have the status of potential ARARs. However, TBC requirements can be considered along with ARARs in determining the level of cleanup for protection of human health of the environment.

Three categories of ARARs were defined to clarify how to identify and comply with environmental requirements. They include action-specific, location-specific, and chemical-specific requirements. Action-specific ARARs control or restrict the design, performance, and other aspects of implementation of specific remedial activities. Location-specific ARARs reflect the physiographic and environmental characteristics of the unit or the immediate area and may restrict or preclude remedial actions depending on the location or characteristics of the unit or the immediate area, and may restrict or preclude remedial action, depending upon the characteristics of the unit. Chemical-specific ARARs are media-specific concentration limits promulgated under Federal or State law. The NCP requires the development of health-based, site-specific levels for chemicals where such promulgated limits for the particular contaminant and/or media do not exist and where there is concern with their potential health or environmental effects.

Table 4 summarizes potential ARARs for the remaining coal ash and coal fines OUs.

2.1.2 Development of Preliminary Remedial Goals

PRGs represent the preliminary media-specific goals and serve as a standard by which to measure whether a selected remedial action has met its RAO. PRGs can be qualitative statements (e.g., indirect actions that prevent receptor contact), numerical values often expressed as concentrations in media (e.g., risk-based soil or sediment concentrations) or specific actions to eliminate contact with contaminated media (e.g., installation of engineered barriers, placement of caps and covers, etc.) that achieve the RAO. PRGs become finalized as cleanup levels following public comment and approval of the SB/PP. The PRGs for the selected remedy are documented as cleanup levels in the ROD. Numerical PRGs consist of a range of risk-based concentrations for RCOCs that provide a basis for selecting the final remedial action to achieve such values. Risk-based clean-up

level calculations for the remaining coal ash and coal fines OUs are provided in Appendix F and summarized in Table 5.

The selection of final cleanup levels is made by the risk managers for the SRS. The risk managers are the key decision makers and include representatives of the USDOE, SCDES, and USEPA.

Risk-based PRGs for the HH RCOCs and CM RCOCs area identified for the remaining coal ash and coal fines OUs. No ecological RCOCs or PTSM RCOCs have been identified. The development of PRGs for the remaining coal ash and coal fines OUs is described below.

The CM analysis is presented in Appendix B. The CM analysis identified CM RCOCs in the vadose zone for the HAB OU (Ba, U-233/234, U-235, U-238) and the LAB OU (Ba) with the potential to migrate to groundwater and exceed groundwater protection standards within 1,000 years. CM PRGs are developed in accordance with the *Contaminant Migration Preliminary Remedial Goals* protocol in the EC&ACP Regulatory Document Handbook (SRNS 2023). There were no CM RCOCs identified for the AAP and ACPRB OU, KAB OU, or FAL OU. The HAB OU and LAB OU CM PRGs for unit ash/soil media are provided in Table 5.

The HHRA is presented in Appendix C. HH RCOCs were identified in surface ash/soil media for the industrial worker and residential receptor scenarios that were evaluated in the HHRA, and PRGs are provided for each as appropriate. Human health risk-based PRGs are developed in accordance with the *Human Health Preliminary Remedial Goal Options* protocol (SRNS 2023b). Risk-based PRGs are calculated for the future resident and future industrial worker at various target risk levels (1E-06, 1E-05, and 1E-04) as well as the corresponding HQ levels (0.1, 1, and 3). The HH PRGs for surface ash/soil media at for the remaining coal ash and coal fines OUs are provided in Table 5.

2.1.3 Most Restrictive and Most Likely PRGs

The most restrictive PRG for HH RCOCs and CM RCOCs are identified as the lowest of the PRGs and are summarized in Table 5.

In contrast to the most restrictive PRGs, the most likely PRGs also consider a comparison to background levels. Because of the inherently conservative nature of the risk assessment and PRG calculations, it is possible for the risk-based PRG to be less than what occurs naturally in unimpacted background soil. In this case, the PRG defaults to the background concentration to be technically practical to achieve. The background concentration is set as the 95th percentile for unimpacted SRS-wide soil.

The most restrictive PRGs and most likely PRGs presented in Table 5 are a good starting point for developing remedial alternatives. Final remedial goals will be agreed upon by USDOE, SCDES, and USEPA concurrent with selection of a remedial action. Final remedial goals will be documented in the ROD.

2.2 General Response Actions

General response actions are unit-specific actions that achieve RAOs and satisfy the requirements of the NCP. The following general response actions have been identified for the remaining coal ash and coal fines OUs.

1. No Action
2. LUCs
3. Containment
4. Excavation

These response actions may be implemented individually or in combination.

2.2.1 No Action

The No Action response is not a technology but is required by the NCP as a baseline for comparison with other remedial actions. In this scenario, no efforts would be taken to monitor, remove, treat, or otherwise mitigate the potential spread of contaminants from the remaining coal ash and coal fines OUs. Contaminant reduction would be achieved only through any natural attenuation that may occur.

2.2.2 LUCs

LUCs include engineering controls (i.e., access controls) and institutional controls (i.e., administrative measures) that minimize the potential for human exposure to contaminants. Generally, LUCs are retained for use if necessary, in conjunction with other remedial alternative(s) ultimately selected at the area or as a stand-alone alternative. LUCs already exist at SRS and can be implemented at the remaining coal ash and coal fines OUs.

Access controls involve temporary or permanent physical restrictions to prevent or reduce human exposure to contaminants. Controls also can be used to prevent vandalism of on-site remedial equipment or disturbance of contaminated media. Regular monitoring and maintenance of access controls are required for this technology to effectively deter site entry. Access controls may include, but are not limited to, signs, fencing, barricades, or exclusion devices.

Access controls that are effective in minimizing the potential for human exposure from direct contact with contaminated media are relatively easy to implement and low in cost when compared to other technologies. However, access controls would not be effective in preventing off-site CM or exposure to ecological receptors. Access controls are retained to deter intruders and will be part of all alternatives in which contaminated media are left on the unit at risk levels that prohibit unrestricted use.

Administrative controls can be used to prevent or reduce future human exposure to contaminants remaining on the site. For example, excavation permit restrictions can be used to permanently prohibit excavation or subsurface construction. Administrative controls also can be temporary measures used while other remedial actions are taking place.

In the long-term, if the property is ever transferred to nonfederal ownership, the United States Government would, in compliance with Section 120(h) of CERCLA, create a deed for the new property owner. The deed would include notification disclosing the former waste management and disposal activities as well as remedial actions taken onsite and any continuing groundwater monitoring commitments.

2.2.3 Containment

Containment technologies involve the construction of engineered barriers to isolate contaminated media. Containment is this case is in situ containment at the location of the waste unit. Properly constructed and maintained engineered barriers are effective and reliable at minimizing or eliminating human and ecological exposure to contaminants and minimize leaching, direct radiation exposure, mobility, and bio-uptake of contaminated media. The use of engineered containments such as capping and soil cover systems are very effective and have reasonable permanence but must be maintained (monitored and repaired as a part of LUCs) as long as the contaminated media remains in place. Containments can be constructed of natural material and/or synthetic material (i.e., geotextile membranes); however, containments constructed of natural material typically require less maintenance. Effective slopes need to be planned into the design to prevent erosion but still enhance runoff of precipitation away from the cover to prevent infiltration through the upper containment layers. Other key design features of properly designed containment also require a well-established vegetation layer to promote evapotranspiration, surficial drainage system, and a drainage layer to divert infiltration water to the external drainage system.

2.2.4 Excavation

Excavation (or removal) can be accomplished by scraping, cutting, digging, scooping, and vacuuming, with heavy earth moving equipment and using conventional construction methods. Excavation is both effective and permanent since wastes are removed from the unit. For the remaining coal ash and coal fines OUs, beneficial reuse applications for the excavated ash material is the preferred removal pathway. Because the contaminated media is both removed and then isolated by incorporating it into an approved beneficial reuse application (i.e., fill material or concrete additive, etc.), this alternative is effective and reliable at eliminating human and ecological exposure to contaminants and prevents direct radiation exposure, reduces mobility, and bio-uptake of contaminated media. The ash would be consolidated and excavated with heavy earth moving equipment and transported for beneficial reuse.

2.3 Identification and Evaluation of Technology Types and Process Options

Various technologies and approaches exist for implementing the four general response actions for the remaining coal ash and coal fines OUs. The NCP requires these potential technologies be screened against the criteria of effectiveness, implementability, and cost. All the technology types suitable for this project are conventional and reliable. Table 6 summarizes the general response actions, remedial technologies, relative costs, and synopsis of the screening.

Effectiveness: An effective technology must achieve the specified RAOs, must be compatible with the contaminant characteristics and waste unit conditions, and must be protective of human health and the environment in both short-term and long-term scenarios. Technologies that do not meet RAOs are significantly less effective than comparable approaches. Technologies that have not been demonstrated successfully at similarly contaminated waste units are eliminated from further consideration.

Implementability: Technologies are evaluated based on the technical feasibility, availability of resources and equipment, and the administrative or institutional feasibility of implementation. Implementable technologies are those that can be readily installed in a cost-effective and timely fashion and that will not elicit substantial public concern from the surrounding community. Mobilization and permitting requirements must be workable and must have been previously demonstrated at similar projects. Consideration is also given to regulatory constraints such as waste handling, disposal, and treatment requirements that would affect the implementation of a technology.

Cost: A qualitative cost evaluation is provided so that comparisons can be made between general response actions. Qualitative evaluations take into consideration capital costs and O&M costs. For screening purposes, the costs of technologies are typically described as high, medium, or low relative to others in the same general category.

2.3.1 No Action (Retained)

This response action would not require the deployment of any technology to reduce the toxicity, mobility, or volume through treatment of the ash or otherwise mitigate the potential spread of contaminants from the ash. The No Action response action could be readily implemented and would have no cost. There would be no reduction in risk and the RAO would not be attained. There is also no five-year remedy review under CERCLA. The No Action alternative is implementable and is the least costly response action, but it is not effective.

2.3.2 Land Use Controls (Retained)

This response action leaves hazardous substances in place that present a potential risk to the industrial worker and/or resident. LUCs would be required to be in place as long as the ash remains in the remaining coal ash and coal fines OUs. Both administrative and engineering controls would prevent exposure of potential human receptors to contaminants by limiting access to the land or resource use. LUCs are relatively simple and inexpensive to implement and may be retained as an independent alternative or in conjunction with another remedial alternative(s). LUCs may also be used to supplement engineering controls to ensure their continued effectiveness. Engineering barriers such as warning or no trespassing signs, fencing, and barricades can prevent human access to contaminated media. Five-year remedy reviews under CERCLA would be required.

LUCs are relatively low in cost, provide a high degree of protection of human health, and are relatively simple to implement. LUCs would not be protective in preventing exposure of ecological receptors. However, LUCs would prevent further damage to the area caused by earth moving activities from more aggressive removal technologies. LUCs are retained for further consideration in the detailed analysis.

2.3.3 Containment (Retained)

Containment technologies involve the construction of engineered caps and soil cover systems to isolate contaminated media. Technologies include capping, horizontal barriers, synthetic membrane covers/liners, and low permeability soil cover systems. Properly constructed and

maintained containments are effective and reliable at preventing direct exposure to contaminants and at minimizing leaching, erosion, mobility, and bio uptake.

Containment technologies are readily implementable but require a planned design and long-term O&M of the cover system. Cost for containment is considered relatively high while the effectiveness of containment technologies depends upon the materials used, the design and effectiveness of the drainage layer, design and effectiveness of the capping layer, establishment of a vegetative layer, and effective slope of the cover layer to encourage runoff and reduce infiltration. Natural clay materials are less susceptible to perforation, but synthetic materials can tear or be easily perforated during installation thus compromising the integrity of the cover. Cover integrity must be maintained for as long as contaminants will persist or until degradation or decay of the contaminants renders them harmless. Containment technologies would effectively reduce risk for the HH receptor and CM scenarios. Five-year remedy reviews under CERCLA would be required. Containment is retained for further consideration in the detailed analysis.

2.3.4 Excavation (Retained)

Excavation of contaminated soil media is one of the most aggressive approaches to implement remediation. Contaminated ash media could be excavated and hauled to a beneficial reuse receiving facility such as the Saltstone Disposal Units (SDUs) for use as fill material for final closure of the SDUs, or to a cement production facility for use in the cement/asphalt applications or products. Excavation is readily implementable, and the earthwork required for excavating the contaminated ash media is standard construction practice.

The cost of excavation could be substantial based upon the volume of contaminated media and the transportation costs of the ash, but the savings on the receiving end offsets the upfront costs if the material is used for beneficial reuse. Removing contaminated ash media from the remaining coal ash and coal fines OUs would effectively eliminate risk for the HH receptor and CM scenarios by permanently removing the ash. Excavation is retained for further consideration for beneficial reuse in the detailed analysis.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section provides the development of alternatives and a screening analysis of the remedial alternatives for the remaining coal ash and coal fine OUs based on the general technologies retained from Section 2.3.

3.1 Development of Alternatives

Three remedial alternatives (No Action, LUCs with Beneficial Reuse, and Class III Cover with LUCs) have been developed for the remaining coal ash and coal fine OUs and are discussed in detail below.

3.1.1 Alternative A-1: No Action

The No Action alternative is required by the NCP to serve as a baseline for comparison with other remedial alternatives. Under this alternative, no effort would be made to control access; limit exposure; or reduce toxicity, mobility, or volume of constituents of concern at the ash units. This alternative would leave the ash units in their current condition with no additional controls. This alternative does not include five-year remedy reviews.

3.1.2 Alternative A-2: LUCs with Beneficial Reuse

Alternative A-2 would be implemented to restrict access to contaminated media via warning signs and other SRS controls until a beneficial reuse option (e.g., backfill material beneath cover systems or concrete additive) is available.

This alternative A-2, LUCs with Beneficial Reuse, would be implemented in a two-phase approach. Phase one would implement LUCs for each of the remaining coal ash and coal fines OUs. LUCs would include posting of warning signs, and establishment of administrative controls. General public access to the site is limited to site workers. LUCs will also include administrative measures as managed through the SRS Site Use/Site Clearance Program to require authorization before beginning work activities at the site. Proposed LUC boundaries are provided in Figures 22 – 26. LUCs would be applied to the entire area of ash and coal fines within and outside of the unit

boundaries. The estimated area for LUCs includes ~1.03 ha (2.55 ac) for AAP, ~1.06 ha (2.62 ac) for ACPRB, ~7.48 ha (18.48 ac) for FAL OU, ~12.73 ha (31.46 ac) for HAB OU, ~6.06 ha (14.97 ac) for KAB OU, and ~7.80 ha (19.28 ac) for LAB OU. The unit-specific LUCs for the ash sites will be included in the ROD. Five-year remedy reviews would be conducted. Due to the CM concerns at the HAB and LAB OUs, groundwater monitoring wells would be installed/identified at these two OUs and would be monitored every five years to coincide with the five-year remedy reviews. Groundwater monitoring would include four groundwater monitoring wells at each OU, one upgradient and three downgradient. Groundwater beneath the FAL OU would continue to be monitored semi-annually in accordance with its Industrial Wastewater Treatment (IWT) permit. The AAP and ACPRB OU and the KAB OU have no CM risk and would not require a groundwater monitoring component under Alternative A-2. Additionally, the AAP is currently monitored (i.e., inclinometers, LIDAR surveys) annually for slope stability due to its proximity to the unnamed tributary of Tims Branch. This monitoring will continue until the ash is removed. LUCs with groundwater monitoring for HAB, LAB, and FAL OUs will remain in place until the ash is excavated and transported to its beneficial reuse location.

Phase 2 of the implementation includes excavation of the ash and its beneficial reuse. Excavation would be applied to the full volumes of ash and coal fines within and outside of the unit boundaries (~53,519 m^3 [70,000 yd3] for AAP, ~7,646 m^3 [10,000 yd^3] for ACPRB, ~163,201 m^3 [213,459 yd^3] for FAL OU, ~198,105 m^3 [259,112 yd^3] for HAB OU, ~208,362 m^3 [272,527 yd^3] for KAB OU, and ~246,971 m^3 [323,026 yd^3] for LAB OU). Excavation of ash material to allow for unrestricted use is the goal. Following completion of the excavation activities, confirmation sampling will be performed. After sampling indicates cleanup levels have been achieved, the ash units will be restored (i.e., contoured for proper drainage and revegetated as necessary).

Proven unencapsulated beneficial reuse alternatives for coal ash/fines include use as fill material. SRS will have a need for large quantities of fill material for the closures of waste storage facilities such as the SDUs or F-Area and H-Area Tank Farms. Coal ash/fines can be used as lower fill material as part of the cover systems at these receiving facilities. Regulatory acceptance of unencapsulated uses of fly ash requires demonstration that there will be no unacceptable releases of contaminants to the environment, and the ash has acceptable geotechnical characteristics.

Preliminary analysis indicates that the ash material would be acceptable as lower fill material. If necessary, additional testing will be conducted to meet design criteria as the designs for these cover systems are finalized. Another beneficial reuse alternative includes using the coal ash/fines as an additive or replacement for cement in concrete mixes, improving the durability and strength of concrete products.

Given that the specific reuse option has not been determined, it is unclear what the costs (if any) would be for transportation of the ash for reuse. Therefore, SRS plans to include only the costs for the excavation of the ash from the unit in the remedial alternative cost for LUCs with beneficial reuse. Any costs associated with transportation of the coal ash/fines to the receiving facility or location for beneficial reuse that would be incurred by Area Completion Projects (ACP) will be documented in the Post Construction Report/Remedial Action Completion Report (PCR/RACR) following remedy implementation.

This alternative would require five-year remedy reviews until the excavation and beneficial reuse component (phase 2) of the remedy is completed.

3.1.3 Alternative A-3: Class III Cover with LUCs

Alternative A-3 would include the use of a cover system and LUCs to prevent direct exposure to contaminated media. A Class III cover system would be constructed over the ash basins as a final action, with the exception of AAP. A long-term permanent cover system at AAP is not advisable due to its proximity to the unnamed tributary to Tims Branch. Therefore, the alternative for a cover system for AAP was not evaluated. Instead, the ash from AAP would be excavated and hauled to the ACPRB to be placed under a cover system. Containment would apply to the area of the boundary of ACPRB, ~1.06 ha (2.62 ac).

LUCs as part of Alternative A-3 would include the posting of warning signs, establishment of administrative controls, and establishment of deed restrictions. LUCs would be applied to the entire area of ash and coal fines within and outside of the unit boundaries (~1.06 ha [2.62 ac] for ACPRB, ~7.48 ha [18.48 ac] for FAL OU, ~12.73 ha [31.46 ac] for HAB OU, ~6.06 ha [14.97 ac] for KAB OU, and ~7.80 ha [19.28 ac] for LAB OU). Proposed LUC boundaries are provided in

Figures 22 – 26. General public access to the site is limited to site workers. LUCs will also include administrative measures as managed through the SRS Site Use/Site Clearance Program to require authorization before beginning work activities at the site. Other administrative measures include property record notices and restrictions if the property is ever transferred to non- federal ownership to disclose former waste management and disposal activities. This alternative would also include installing four groundwater monitoring wells, one upgradient and three downgradient at all OUs with the exception of the FAL OU that currently has groundwater monitoring under the IWT permit. Groundwater monitoring is required at all OUs as part of closure requirements under the CCR regulations for landfills/impoundments and will coincide with the five-year remedy reviews. Monitoring at the FAL OU will be monitored semi-annually in accordance with its IWT permit.

In preparation for the installation of a Class III cover system, Alternative A-3 would include clearing vegetation and trees, grubbing tree stumps, stockpiling at site perimeter, constructing access roads and, where applicable, draining the basins and drying the ash. Ash located outside of the OUs would be consolidated as appropriate under the cover system. Containment would be applied to the full area of the unit boundary of FAL OU, ~7.48 ha (18.48 ac). To minimize the cover areas, the ash would be consolidated to one side of each ash basin. Containment would apply to the consolidated areas of ~6.35 ha (15.70 ac) for HAB OU, ~3.04 ha (7.50 ac) for KAB OU, and ~3.88 ha (9.60 ac) for LAB OU. The area where the ash was removed would be clean closed. The cover system would consist of a SCDES Class III Landfill Geosynthetic Cover, an average 6-inch thick compacted and graded structural fill layer, a geosynthetic layer (including a flexible membrane layer), a drainage layer, a riprap perimeter drainage, a 20-inch common fill layer, a 4-inch topsoil layer, and a vegetative cover (e.g., sod).

This alternative would require five-year remedy reviews as long as the contaminated media remains in place.

3.2 Screening of Alternatives

In this section, the identified alternatives are evaluated against the CERCLA criteria of effectiveness, implementability, and cost. The retained alternatives will be analyzed in detail in Section 4.0.

For an alternative to be effective, it must achieve specified objectives, must be compatible with the contaminant characteristics and unit conditions, and must be protective of human health and the environment in the long term. The alternative must also be effective in reducing the risk to human health and the environment in the short term (during construction and construction execution). In, addition, to the extent practicable, each alternative should be effective in decreasing the inherent threats or risks associated with hazardous substances or media by reducing toxicity, mobility, or volume through treatment. Permanence of the action is also considered. Alternatives that do not provide adequate protection of human health and the welfare of the environment or that do so to a much lesser extent than a comparable alternative are screened out and not considered during the detailed analysis.

Implementability addresses both the technical and institutional feasibility of applying a technology. Under this criterion, technologies are evaluated based on the technical feasibility to construct, reliably operate, and meet action-specific regulations for the particular treatment. Operation, maintenance, and monitoring of technical components of the alternative, if required after the remedial action is complete, are also considered. Institutional feasibility of an alternative refers to the ability to obtain necessary approvals and the availability of treatment, storage, and disposal services and capacity, as needed, as well as availability of specific equipment, technical specialists, and other related components.

The nature of the alternative should be such that it can be implemented in a cost effective and timely manner. In addition, the implementation of the technology should not elicit substantial public concerns in the community. Site accessibility, available area, and potential future use of the property may affect the implementation of a specific technology. Mobilization and permitting or approval requirements must be workable and previously demonstrated at similar projects. Preliminary consideration is also given to regulatory constraints such as waste handling, disposal, and treatment requirements that would affect the implementation of a technology. These considerations will be evaluated further during the detailed analysis for retained alternatives when action-specific ARARs are developed. Screened out alternatives will not be considered during the detailed analysis.

A qualitative cost evaluation is provided so that cost comparisons can be made among the alternatives. Remedial alternative costs are described as high, medium, or low relative to other technologies in the same general response action category. Qualitative evaluations take into consideration capital costs and O&M costs. These estimates are based on prior estimates, previous experience, and engineering judgment. Alternatives demonstrating comparable levels of effectiveness and implementability, but a significantly greater cost, will be rejected. Otherwise, cost will not be used as a criterion to screen the technologies at this point in the FCMS/FS process.

The proposed remedial alternatives for the remaining coal ash and coal fines OUs were evaluated and screened using the three criteria of effectiveness, implementability, and cost. The results of the evaluation are described in the following sections. Table 7 summarizes the results of this screening.

3.2.1 Alternative A-1: No Action

Under the No Action alternative, no remedial efforts would be taken to control risk, treat or remove contaminated media. This alternative is not effective in achieving the RAOs. Implementability is not a consideration since no action would be implemented. There is no capital construction or system O&M costs for the No Action alternative. However, in accordance with the NCP, this alternative is carried forward to serve as a baseline for comparison with other remedial alternatives.

3.2.2 Alternative A-2: LUCs with Beneficial Reuse

Alternative A-2 is effective in protecting human health and the environment. Human health and the environment would be protected in the short term through implementation of LUCs, as administrative controls will prevent worker exposure to the ash. Human health and the environment would be protected in the long term through excavation of the ash and subsequent beneficial reuse, the waste units will be available for unrestricted use.

Phase 1 of Alternative A-2 is readily implementable due to the previously successful implementation of LUCs at other locations on the SRS. Installation of groundwater monitoring wells associated with this action is routinely implemented at SRS. Phase 2 (excavation and

beneficial reuse) is also considered to be implementable, e.g., the likely use of the ash material as fill for a large cover system.

The cost of this alternative is considered medium because the costs for excavation of the ash material for beneficial reuse is included in the estimate. Additional costs are signage, excavation permit restrictions, a Land Use Control Implementation Plan (LUCIP), mandatory five-year remedy reviews, and any necessary deed restrictions. This alternative is determined to be effective and is retained for detailed analysis.

3.2.3 Alternative A-3: Class III Cover with LUCs

Alternative A-3 is effective in protecting human health and the environment. Containment technology will involve the construction of engineered cover systems to isolate contaminated media. Protection in the short term (construction phase) would be achieved through the use of best management practices (BMPs) and strict adherence to the project specific health and safety plan. Human health and the environment would be protected in the long term due to the presence of the cover system provided O&M of the soil cover remains. This alternative, a Class III cover system, achieves the CM RAOs. LUCs will meet the HH RAOs to be protective of the industrial worker and hypothetical residential receptor.

Alternative A-3 is readily implementable as demonstrated by previously successful implementation of cover systems and LUCs at SRS and experience with the common construction methods and equipment used to implement this type of alternative. Installation of groundwater monitoring wells associated with this action is routinely implemented as SRS. LUCs have been implemented successfully at SRS on numerous projects and are fully employed in all areas of the site. However, Alternative A-3 cannot be implemented quickly. Budget constraints would likely stretch out implementation for 5-10 years.

This alternative is considered to have a comparatively higher cost due to the stormwater management, transportation, and placement of large quantities of fill material, material and construction costs associated with the Class III cover system, including placement of a vegetative cover.

This alternative is retained for further analysis as it is effective and can be implemented.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section discusses the relative strengths and weaknesses of the three alternatives retained from the screening analysis in Section 3.2 with respect to each of the nine CERCLA evaluation criteria. The NCP [40 CFR 300.430(e) (91)] requires that potential remedial alternatives undergo detailed analysis using relevant criteria that will be used by decision makers to select a final remedy. The results of the detailed analysis are then examined to compare alternatives and identify key tradeoffs among alternatives.

The Natural Resource Injury Evaluation (NRIE) Checklist and supporting descriptions are provided in Appendix G. The purpose of the NRIE Checklist is to identify potential natural resource injuries associated with CERCLA remedial activities. Based on the NRIE Checklist, natural resources in the locale have been impacted by hazardous substances from the unit. Remedial alternatives under consideration may or may not address injuries to the natural resources. Remedial alternatives considered may cause additional injury based on the scope of the action. No irreversible or irretrievable resource losses are known to exist.

Although a comparative analysis of alternatives is provided in this FCMS/FS report, this document does not propose a preferred alternative. The preferred alternative will be presented in the SB/PP. The preferred alternative will be based on information contained in this report and comments received from USEPA, SCDES, and the public prior to finalization in the ROD.

4.1 Individual Analysis of Alternatives

The statutory requirements that guide the evaluation of remedial alternatives under CERCLA state that a remedial action must:

- Be protective of human health and the environment,
- Attain ARARs or define criteria for invoking a waiver,
- Be cost effective,

- Use permanent solutions to the maximum extent.

USEPA has established nine evaluation criteria to address these statutory requirements under CERCLA. The criteria fall into the categories of threshold criteria, primary balancing criteria, and modifying criteria. Modifying criteria (i.e., State or support agency acceptance and community acceptance) will be evaluated after the public comment period on the SB/PP. Evaluation criteria categories and the nine evaluation criteria are listed and explained in the following sections.

A detailed analysis of each alternative is provided for each of the following evaluation criteria:

Threshold Criteria

Each alternative must meet the following threshold criteria to be selected as a permanent remedy under CERCLA:

- **Overall protection of human health and the environment** – The overall protection of human health and the environment is evaluated for each alternative on the basis of how the alternative reduces the risk of exposure to contaminants from potential exposure pathways through engineered barriers or LUCs. Each alternative is examined as to whether it creates any unacceptable short-term risks to human health. In addition, the RCRA criterion specifying control of source releases is evaluated.
- **Compliance with ARARs -** Remedial actions under CERCLA must attain all ARARs. ARARs are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal, State, or local environmental law that specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Three types of ARARs (chemical- , action- , and location-specific) have been developed to simplify identification and compliance with environmental requirements. Location-specific ARARs were evaluated to determine applicability to the combined report. The summary of potential ARARs is provided in Table 4.

Primary Balancing Criteria

Primary Balancing criteria are factors that identify key tradeoffs among alternatives.

- **Long-term effectiveness and permanence** - Long-term effectiveness and permanence are evaluated for each alternative on the basis of the magnitude of residual risk and the adequacy and reliability of controls used to manage contaminated media that remain after response objectives have been achieved. Alternatives that offer long-term effectiveness and permanence halt or otherwise mitigate any potential for offsite contaminant transport and minimize the need for future engineered controls. The degree of uncertainty with regard to treatment effectiveness is also evaluated.
- **Reduction of toxicity, mobility, or volume through treatment** - The statutory preference is to select a remedial action that employs treatment to reduce the toxicity, mobility, or volume of hazardous substances. The degree to which alternatives employ recycling or treatment is assessed, including how treatment is used to address the principal threats posed by the OU.
- **Short-term effectiveness** - Evaluation of alternatives for short-term effectiveness considers protection of remedial workers, members of the community, and the environment during implementation of the remedial action and the time required to achieve RAOs and cleanup levels. Schedule estimates are based on projected availability of materials and labor and may have to be updated at the time of remediation.
- **Implementability** - Each alternative is evaluated with respect to the technical and administrative feasibility of implementing the alternatives as well as the availability of necessary equipment and services. This criterion includes the ability to obtain services, capacities, equipment, and specialists necessary to construct components of the alternative; the ability to operate the technologies and monitor their performance and effectiveness; and the ability to obtain necessary approvals from other agencies.
- **Cost** - Accuracy of present-worth costs is +50/-30 percent according to USEPA guidance. Detailed cost estimates are derived from current information including vendor quotes, conventional cost estimating guides (e.g., Mean Site Work Cost Data), and costs associated with serial costs, site conditions, competitive market conditions, final project scope, and implementation schedule at the time that the remedial activities are initiated. Real interest rates on U.S. Treasury notes and bonds of specific maturity were used to estimate present-worth costs. Present worth costs for review of the site remedy every five years are given for each

alternative for which residuals remain at the site. Present-worth costs for these items are based on an estimated time frame of operation. Cost estimates are presented in Appendix H.

Modifying Criteria

Modifying criteria (i.e., State or support agency acceptance, community acceptance) will be considered during remedy selection.

- **Community acceptance** – The concerns of the community should also be considered in presenting alternatives that would be acceptable to the community. Community acceptance is evaluated based on comments on the SB/PP received during the public comment period. These comments are considered in the final remedy selection for the ROD and the issuance of a RCRA permit modification.
- **State or Support Agency Acceptance** – The preferred alternative should be acceptable to State and support agencies. The State acceptance criterion is evaluated based on scoping meetings held between USDOE, USEPA, and SCDES, and based on comments received on this FCMS/FS and are addressed in the SB/PP document.

The retained alternatives are be evaluated against the seven CERCLA threshold and balancing criteria that provide the basis for evaluating the alternatives and selecting a remedy. The purpose of this section is to identify key advantages and disadvantages of each alternative. The remaining two modifying criteria will be evaluated in the SB/PP.

4.1.1 Individual Analyses of the Alternatives for the Remaining Coal Ash and Coal Fines OUs

A comparison of alternatives to the primary balancing and modifying criteria are discussed in Sections 4.1.1.1 through 4.1.1.3 and summarized in Table 8.

4.1.1.1 Alternative A-1 - No Action

Alternative A-1 was carried forward as required by the NCP to serve as a baseline for comparison with other remedial alternatives.

Overall Protection of Human Health and the Environment

The No Action alternative would not address potential risk to the human receptors from exposure to the contaminated media remaining coal ash and coal fines OU. This alternative would not achieve the RAOs and would not be protective of human health or the environment. No additional injury to natural resources would be encountered under this alternative.

Compliance with ARARs

Table 4 lists the potential ARARs applicable to the remaining coal ash and coal fines OUs. Specific ARARs applicable to the alternative are listed below.

- *Chemical-Specific ARARs*: No chemical-specific ARARs are associated with the No Action alternative.
- *Location–Specific ARARs*: No location-specific ARARs are associated with the No Action alternative.
- *Action-Specific ARARs*: No action-specific ARARs are associated with the No Action alternative.

Long-Term Effectiveness and Permanence

Potential future exposure to human health from contaminated media at the remaining coal ash and coal fines OU would remain unchanged under the No Action alternative. This alternative does not provide for long-term effectiveness or permanence.

Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction in the toxicity, mobility or volume of contaminated media associated with the No Action alternative.

Short-Term Effectiveness

The No Action alternative would not endanger the surrounding communities or remedial workers or adversely affect the environment during implementation; however, the RAO would not be achieved. Under this alternative, localized soil would remain impacted by leaving hazardous contaminants in place.

Implementability

Since this alternative requires no action, implementability is not a consideration.

Cost

There is no present-worth cost estimated for the No Action alternative since there is no action implemented and no five-year remedy review. Detailed cost estimates are provided in Appendix H. A summary of the estimated cost is below.

Total Present-Worth Cost $0

4.1.1.2 Alternative A-2 - LUCs with Beneficial Reuse

Alternative A-2 consists of implementing LUCs in phase 1 and excavation with beneficial reuse in phase 2 of the remedy implementation.

Overall Protection of Human Health and the Environment

The exposure pathway to human receptors is broken by controlling access and prohibiting unrestricted use of the contaminated media in the short-term, and through excavation and beneficial reuse in the long-term. Contaminant migration modeling indicates contaminants in the ash material only at the HAB OU and the LAB OU have the potential to impact groundwater. However, the CM analysis indicates that the mean travel time for all CM RCOCs at the HAB OU and LAB OU are greater than 400 years, long after the ash material will be removed for beneficial reuse. Even so, groundwater will be monitored at the HAB OU and LAB OU. Thus, Alternative A-2 would achieve all RAOs and is therefore determined to be protective of human health and the environment. Alternative A-2 would not result in any natural resource injury.

Compliance with ARARs

Table 4 lists the potential ARARs applicable to the remaining coal ash and coal fines OUs. Specific ARARs applicable to the alternative are listed below.

Chemical-Specific ARARs: No chemical-specific ARARs are associated with Alternative A-2.

Location-Specific ARARs: Compliance with location-specific ARARs is associated with Alternative A-2. There is a probability that location-specific ARARs will be associated with the excavation of the ash/soil media. Any excavation within any wetland area may require restoration upon completion of the excavation to comply with the applicable ARARs in 10 CFR 1023 (see Table 4). Action will need to be taken to avoid, minimize, or mitigate the destruction, loss, or degradation of wetlands.

Action-Specific ARARs: Compliance with action-specific ARARs is associated with Alternative A-2. In order to minimize erosion of sediment and manage storm water runoff that may occur during the during excavation and removal activities for beneficial reuse, a storm water management plan would be required to comply with SC R. 61-9.122,41. In addition, the disposal and transportation of waste generated from Alternative A-2 would be handled in accordance with Federal and State regulations 40 CFR 262.11(b) and SCDES 61-107.5(D)(3). Coal ash and coal pile runoff are excluded as hazardous, solid waste per 40 CFR 261.4(b)(4)(i) and (ii). Installation of monitoring wells will be in accordance with R.61-71B(2).

Long-Term Effectiveness and Permanence

The long-term effectiveness for protecting human health can be achieved under this alternative as long as LUCs are maintained until the ash is removed for beneficial reuse. The timeframe for LUCs to remain until removal for beneficial reuse is estimated to be more than 12 years. Remedy reviews will be performed every five years, and annual inspections will be performed to ensure warning and no trespassing signs are in place and no encroachment onto the controlled area is occurring. Signs will be replaced and/or repaired as needed and records for site use/site control permits will be maintained within the SRS infrastructure. A LUCIP will be prepared by the USDOE that describes the implementation and maintenance actions for the early remedial action including periodic inspections. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs. The LUCIP will remain in effect unless and until modifications are approved by the USEPA and SCDES as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Phase 2 of the alternative implementation will include excavation of ash material to unrestricted use levels and beneficial reuse of the material. This will be a permanent solution for the ash material and will be protective in the long term.

Reduction of Toxicity, Mobility, or Volume Through Treatment

There is no reduction in the toxicity, mobility, or volume through treatment of contaminated media associated with the Alternative A-2, assuming the beneficial reuse of ash material as fill for a large cover system.

Short-Term Effectiveness

This alternative poses no risk to remedial workers or the community because no work will be performed which disturbs the ash in the remaining coal ash and coal fines OUs until the beneficial reuse option is implemented. Remedial workers would have the greatest risk of exposure during excavation activities. Use of BMPs during excavation and strict adherence to the project specific health and safety plan would prevent worker exposure to hazardous material and would minimize any risk to surrounding communities while excavation activities are performed. All of the ash and contaminated soil media are within an area with restricted access; therefore, it is not accessible to members of the public or community. There is no hazard to nearby communities since there are none in proximity.

Implementability

LUCs have been easily implemented at many waste units at SRS and are currently active in all areas of SRS. The implementation of LUCs presents no technical or administrative impediments.

Alternative A-2 includes beneficial reuse that requires excavating and hauling to the beneficial reuse site. Excavation and hauling have been implemented at several SRS locations including the Dunbarton Bay Ash Unit. The implementation of excavation and hauling presents no technical or administrative impediments.

Cost

Costs associated with this alternative include posting warning signs around the perimeter of each of the remaining coal ash and coal fines OUs where the ash/soil is located. SRS would control access to the OUs through the Site Use/Site Control permit system. A review of the remedy will

be performed every five years until beneficial reuse. Costs for excavating and loading for hauling is included in the cost estimate. A summary of the estimated present-worth cost is presented below:

Total Capital Cost $23,089,898
Present-Worth O&M Cost $16,518,056

Total Estimated Cost $39,607,954265

4.1.1.3 Alternative A-3 - Class III Cover with LUCs

Alternative A-3 consists of placing a SCDES Class III cover system over the ash basins to break the direct exposure pathway, applying LUCs to maintain the integrity of the cover system, and installing groundwater monitoring wells at all remaining coal ash and coal fines OUs to monitor for migration of contaminants.

Overall Protection of Human Health and the Environment

Alternative A-3 breaks the exposure pathway to human receptors by covering the contaminated media and applying LUCs to ensure the permanence of the soil cover. Alternative A-3 would achieve the HH and CM RAOs and is therefore determined to be protective of human health and the environment. Alternative A-3 would not cause additional natural resource injury.

Compliance with ARARs

Chemical-Specific ARARs: No chemical-specific ARARs are associated with Alternative A-3.

Location-Specific ARARs: Compliance with location-specific ARARs is associated with Alternative A-3. There is a probability that location-specific ARARs will be associated with the excavation/consolidation of the ash/soil media. Any excavation within any wetland area may require restoration upon completion of the excavation to comply with the applicable ARARs in 10 CFR 1023 (see Table 4). Action will need to be taken to avoid, minimize, or mitigate the destruction, loss, or degradation of wetlands.

Action-Specific ARARs: Compliance with action-specific ARARs is associated with Alternative A-3. In order to minimize erosion of sediment and manage storm water runoff that may occur during the remedial actions, a storm water management plan would be required to comply with SC R. 61-9.122,41. In addition, the disposal and transportation of waste generated from Alternative A-3 would be handled in accordance with Federal and State regulations 40 CFR 262.11(b) and SCDES 61-107.5(D)(3). Coal ash and coal pile runoff are excluded as hazardous, solid waste per 40 CFR 261.4(b)(4)(i) and (ii). Installation of monitoring wells will be in accordance with R.61-71B(2). Management of CCR will be in accordance with 40 CFR 257.91. Post closure care of the cover system will be in accordance with 40 CFR 258.61(a)(1),(3) and SC R.61-107.19 Part V Subpart F 258.61(a).

Long-Term Effectiveness and Permanence

The long-term effectiveness for protecting human health can be achieved under this alternative as long as the integrity of the Class III cover system is maintained and LUCs are in place. LUCs would include the O&M necessary to maintain the cover system. The Class III cover system will reduce the potential for migration of contaminants to groundwater above groundwater protection standards in the long term at the HAB and LAB OUs. Alternative A-3 would remain in place until the concentration of hazardous substances in the ash/soil is at such levels to allow for unrestricted use and exposure. The timeframe for LUCs is assumed for a duration of 200 years as a basis for a cost estimate. The actual time requirement would likely be longer as the contaminants are long-lived. Remedy reviews will be performed every 5 years. Annual inspections will be performed to ensure warning and no trespassing signs are in place and no encroachment onto the controlled area is occurring. Signs will be replaced and/or repaired as needed and records for site use/site control permits will be maintained within the SRS infrastructure.

A LUCIP will be prepared by the USDOE that describes the implementation and maintenance actions for the early remedial action including periodic inspections. The USDOE is responsible for implementing, maintaining, monitoring, reporting upon, and enforcing the LUCs. The LUCIP will remain in effect unless and until modifications are approved by the USEPA and SCDES as needed to be protective of human health and the environment. LUCIP modification will only occur through another CERCLA document.

Reduction of Toxicity, Mobility, or Volume Through Treatment

There is no reduction in the toxicity, mobility, or volume through treatment of contaminated media associated with the Alternative A-3.

Short-Term Effectiveness

This alternative can be completed within 5-10 years while posing no significant risk to the community or workers. Remedial workers would have the greatest risk of exposure during construction activities. Use of BMPs during construction and strict adherence to the project specific health and safety plan would prevent worker exposure to hazardous material and would minimize any risk to surrounding communities while activities are performed.

Implementability

Class III cover systems with LUCs have been implemented as remedies in several areas of SRS, including the D-Area Ash Basin Disposal Facilities. The implementation of cover systems with LUCs presents no technical or administrative impediments.

Cost

Costs associated with Alternative A-3 include Class III cover systems, which are considered high, and LUCs consisting of posting warning signs around the perimeter of each of the remaining coal ash and coal fines OUs where the ash/soil is located as well as SRS institutionally controlling access to the OUs by Site Infrastructure with the Site Use/Site Control permit system. A review of the remedy will be performed every five years for at least 200-year duration. A summary of the estimated present-worth cost is presented below:

Total Capital Cost $48,165,265
Present-Worth O&M Cost $11,499,505

Total Estimated Cost $59,664,770

4.2 Comparative Analyses

This section identifies key advantages and disadvantages of each alternative in relation to the evaluation criteria. Table 9 provides a summary of the comparative ranking analysis. Each alternative is ranked with respect to the other alternatives for the evaluation criteria.

4.2.1 Overall Protection of Human Health and the Environment

Alternative A-1 would not be protective of human health or the environment. Alternatives A-2 and A-3 are protective of human health and the environment. Alternative A-2 limits human exposure to contaminated ash/soil through the implementation of administrative and engineering controls. After the ash is excavated for beneficial reuse, the remaining coal ash and coal fines OUs are expected to be clean closed. Alternative A-3 breaks the exposure pathway to contaminated media through the use of a protective cover system in addition to the use of administrative and engineering controls. In addition, Alternative A-3 reduces the potential for migration of contaminants to groundwater above groundwater protection standards.

4.2.2 Compliance with ARARs

There are no chemical-specific ARARs for any of the alternatives. Location-specific ARARs associated with the excavation of the ash/soil media in any wetland area ae considered for Alternatives A-2 and A-3. These alternatives achieve the location-specific ARRAs by avoiding, minimizing, or mitigating the destruction, loss, or degradation of wetlands. Excavation within any wetland area may require restoration upon completion of the excavation to comply with the applicable ARARs in 10 CFR 1023 (see Table 4). Action-specific ARARs associated with Alternatives A-2 and A-3 are achieved by employing BMPs to minimize erosion of ash/soil and management of storm water runoff.

4.2.3 Long-term Effectiveness

Alternative A-1 is not effective in the long-term since exposure is not prevented and therefore, ranked the lowest. Alternative A-2 is ranked slightly higher than A-3. Alternative A-2 relies on LUCs to prevent exposure in the near term, but excavation and beneficial reuse will eliminate exposure in the long term. Alternative A-3 can be implemented sooner but relies on long term cover maintenance and LUCs to prevent exposure, as the ash material will remain in place.

4.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the alternatives employ any treatment to reduce the toxicity, mobility, or volume of the contaminated media. As such, all alternatives are given an equally low ranking.

4.2.5 Short-term Effectiveness

Alternative A-1 is not effective in the short-term since exposure is not prevented and therefore, ranked lowest of all the alternatives. Alternative A-2 poses no risk to the industrial worker or surrounding community during implementation. However, Alternative A-3 was ranked higher due to a somewhat shorter time frame to implement. Alternative A-3 was ranked higher because the time to get to beneficial reuse is longer (over 12 years) than the time to place covers on the units. Budget constraints would likely stretch out implementation of Alternative A-3 for 5-10 years.

4.2.6 Implementability

No implementation is required of Alternative A-1; therefore, this alternative was ranked highest. Alternative A-2 was ranked slightly lower than Alternative A-1 because this alternative requires administrative and engineering controls. Alternative A-3 was ranked the same as Alternative A-2 because of its equal implementability.

4.2.7 Cost

A total present worth cost for each alternative was calculated for each remaining ash unit, and presented in Appendix H. The cost estimates include capital and annual O&M costs. Capital costs include direct costs, such as construction, equipment, materials, labor, mobilization, as well as indirect costs such as engineering, health and safety, project management, overhead, contingency, etc. Capital costs were derived from SRS experience, volume estimates based on RI data, etc. O&M direct costs primarily consist of labor for inspections, labor and material for maintenance, and costs of periodic (every five years) reviews. Indirect O&M costs also include project management, health and safety, overhead and contingency. O&M costs were primarily derived from experience at SRS. A present worth analysis is performed for both Capital and O&M costs.

The level of detail is representative of an order of magnitude estimate with an assumed accuracy of +50%/-30%.

4.2.8 Summary

Alternative A-1 does not meet threshold criteria. Alternative A-2 is rated slightly higher than Alternative A-3 for long-term effectiveness. Alternative A-3 is rated slightly higher for Short-Term Effectiveness. Overall, for criteria with numerical values, the Alternative A-2 and A-3 are rated equally. However, Alternative A-2 has a significantly lower cost of $40M versus $60M for Alternative A-3.

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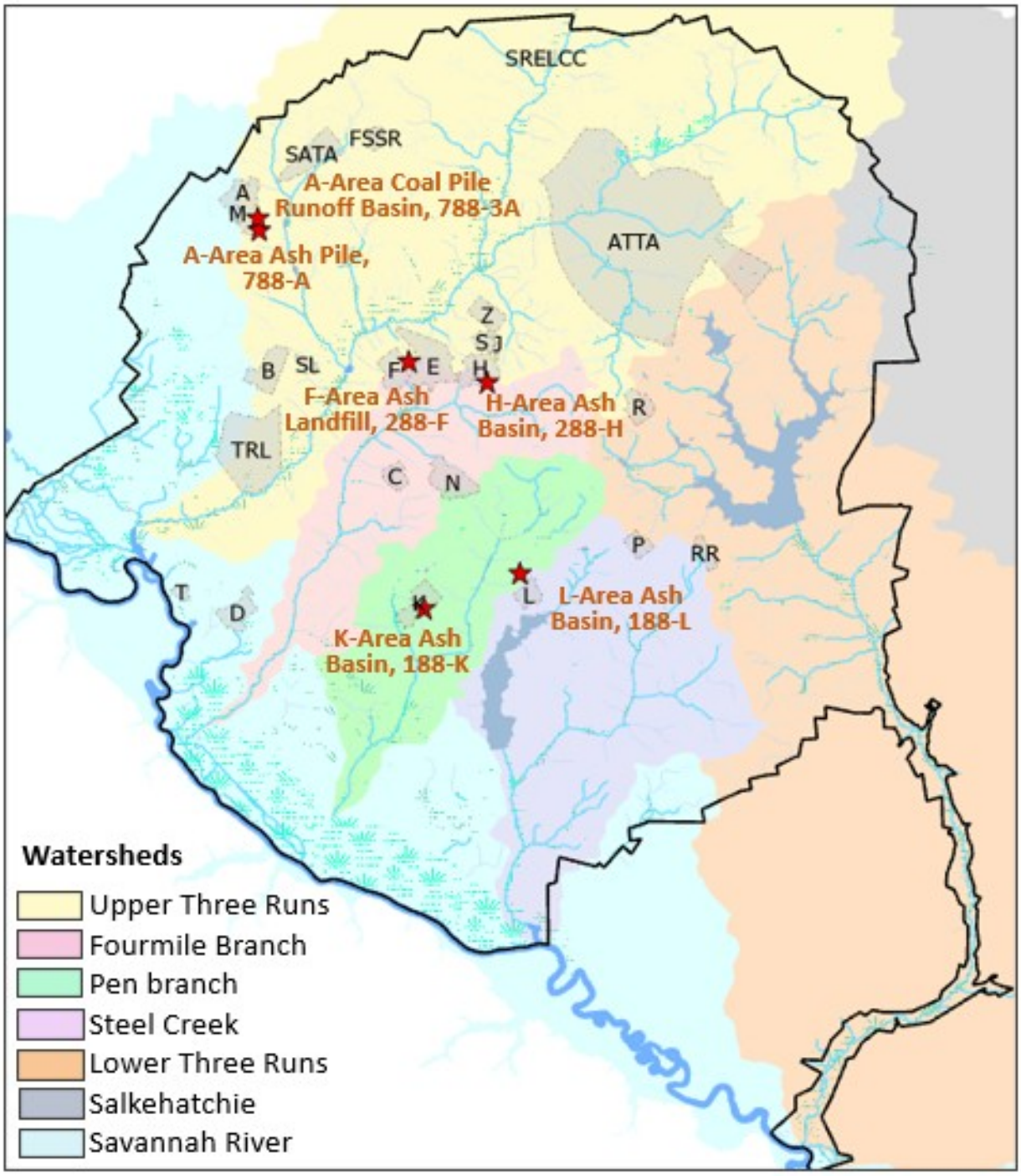


Figure 1 **Location of the Remaining Coal Ash and Coal Fines OUs within the Savannah River Site**



Figure 2 A-Area Ash Pile and A-Area Coal Pile Runoff Basin Operable Unit

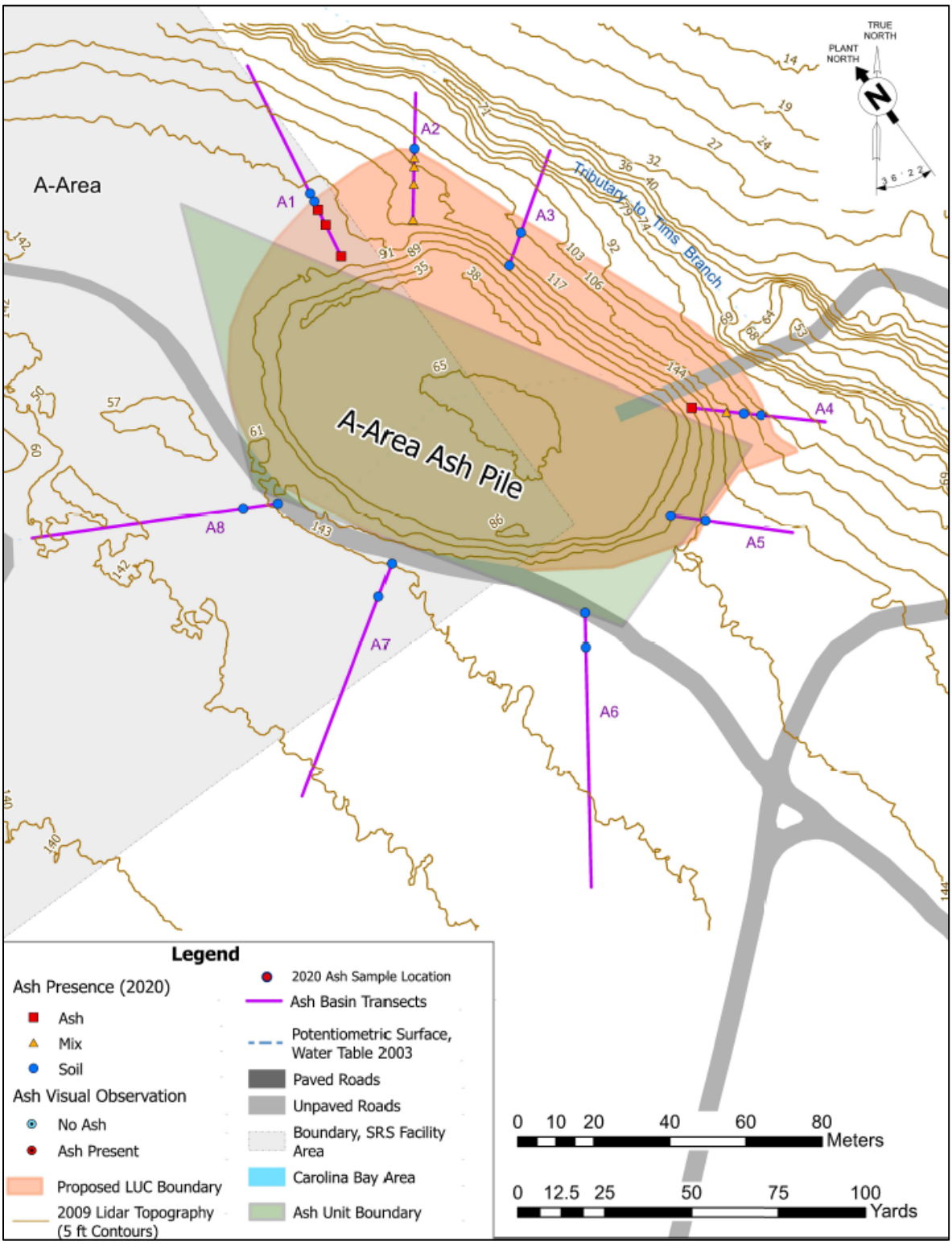


Figure 3 A-Area Ash Pile Topography and Ash Observation Transects

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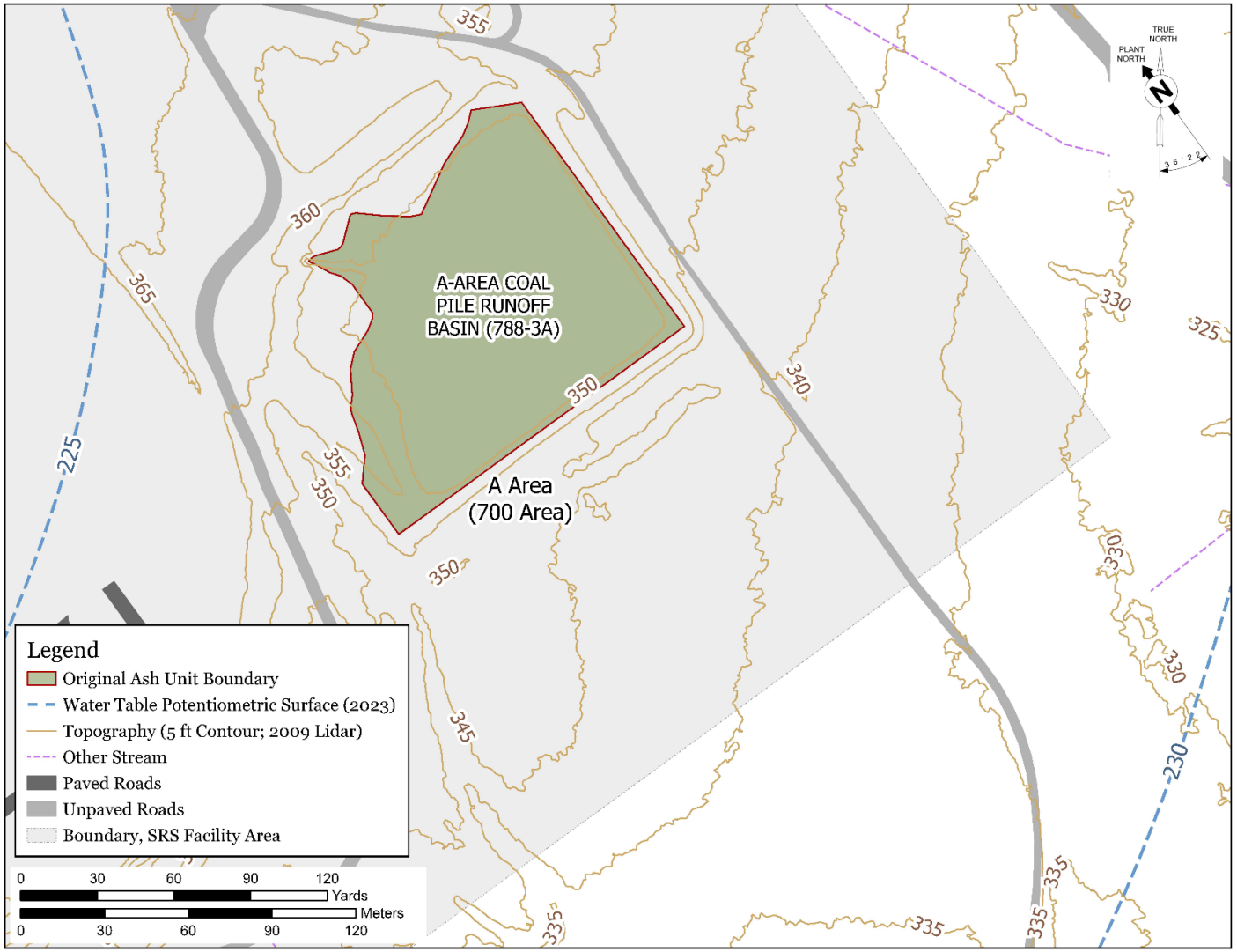


Figure 4 A-Area Coal Pile Runoff Basin Topography

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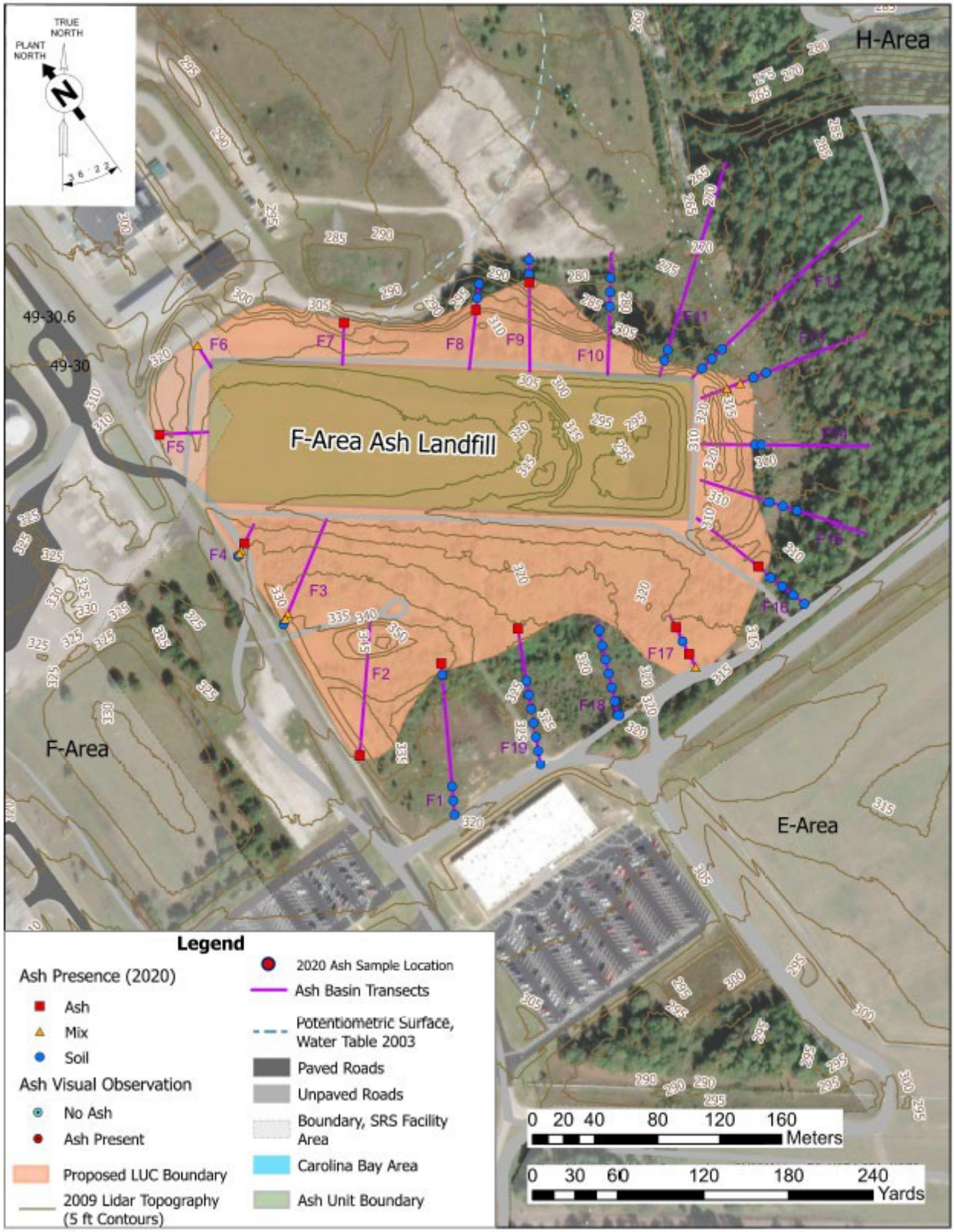


Figure 5 F-Area Ash Landfill OU Topography and Ash Observation Transects

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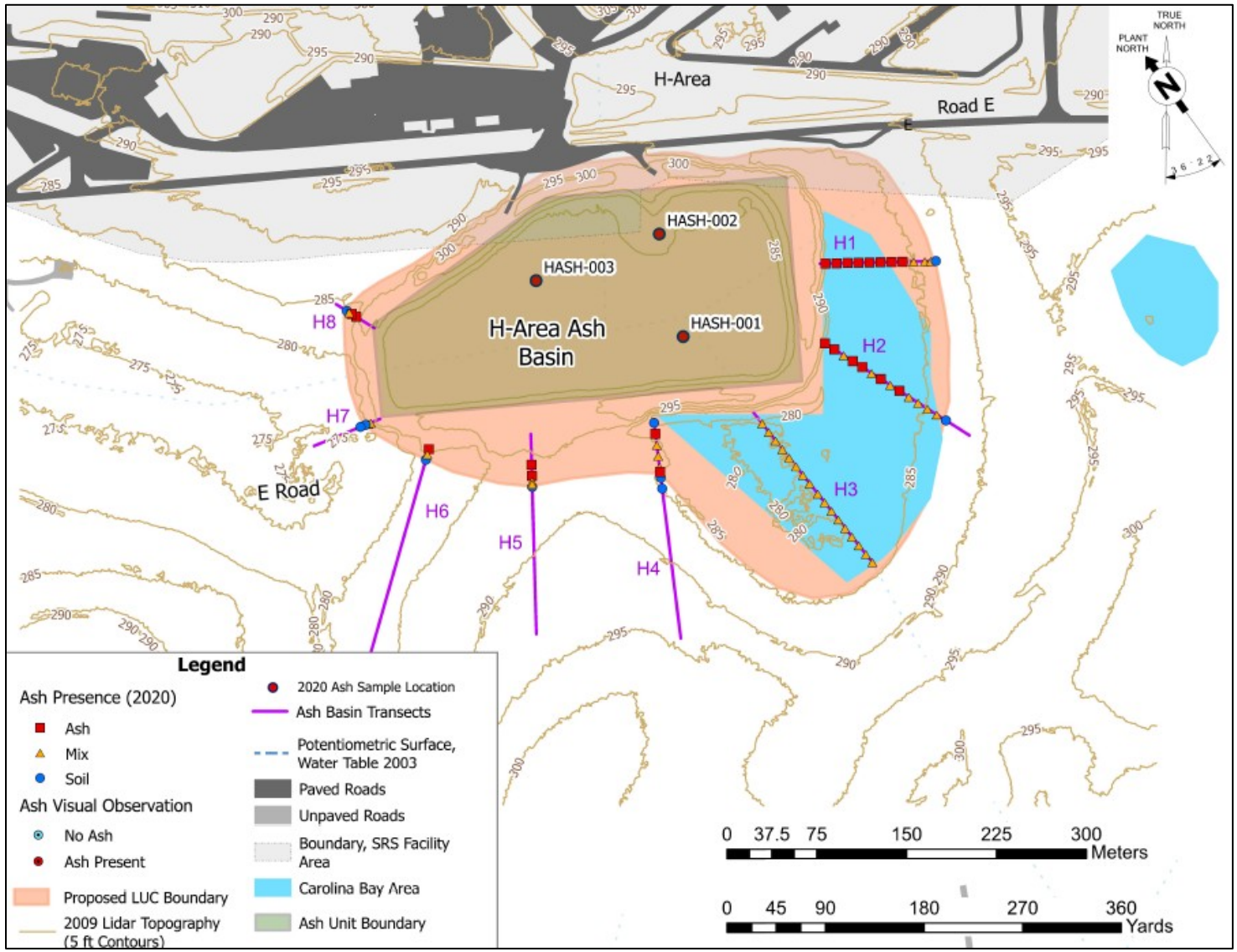


Figure 6 H-Area Ash Basin OU Topography and Ash Observation Transects

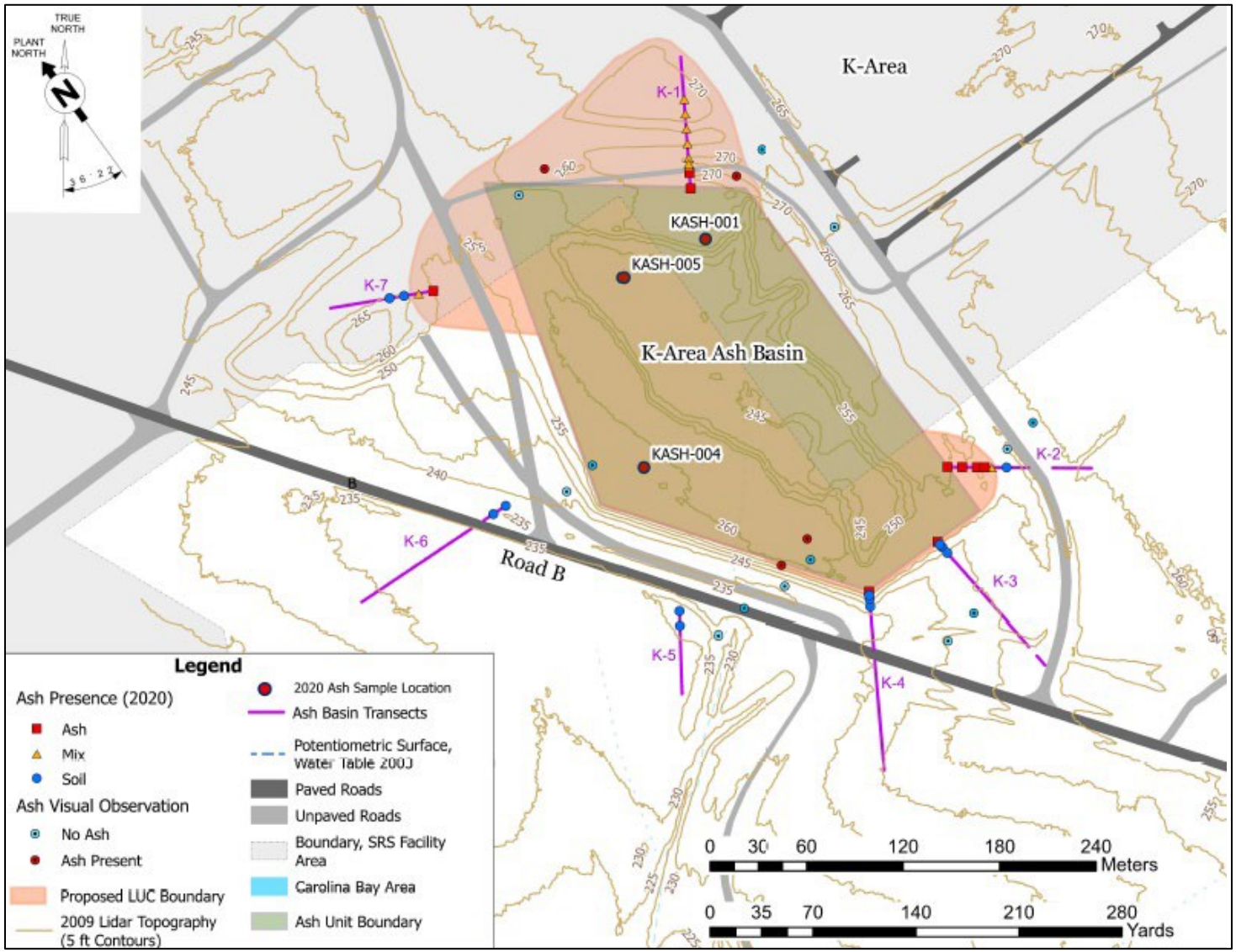


Figure 7 K-Area Ash Basin OU Topography and Ash Observation Transects

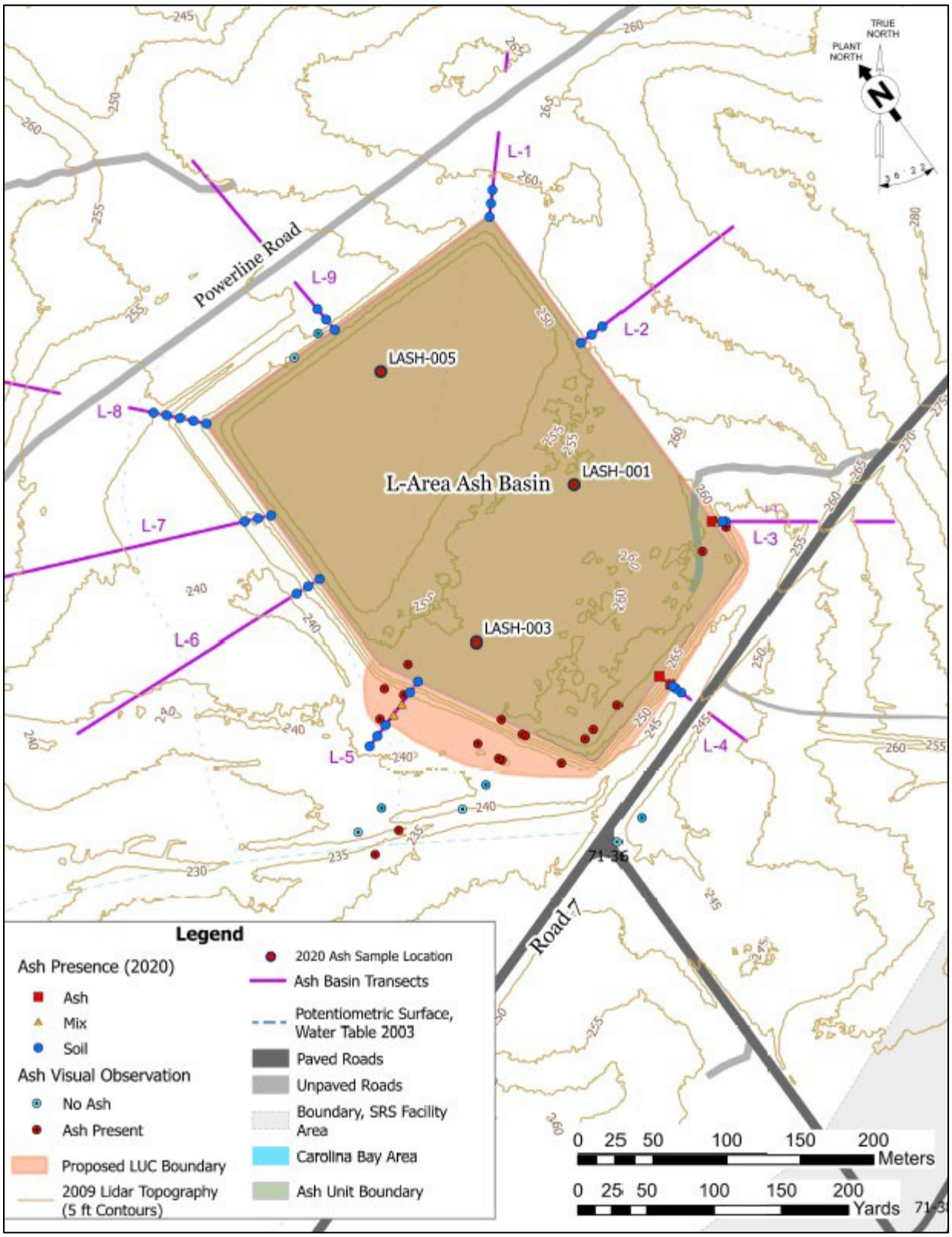


Figure 8 L-Area Ash Basin OU Topography and Ash Observation Transects

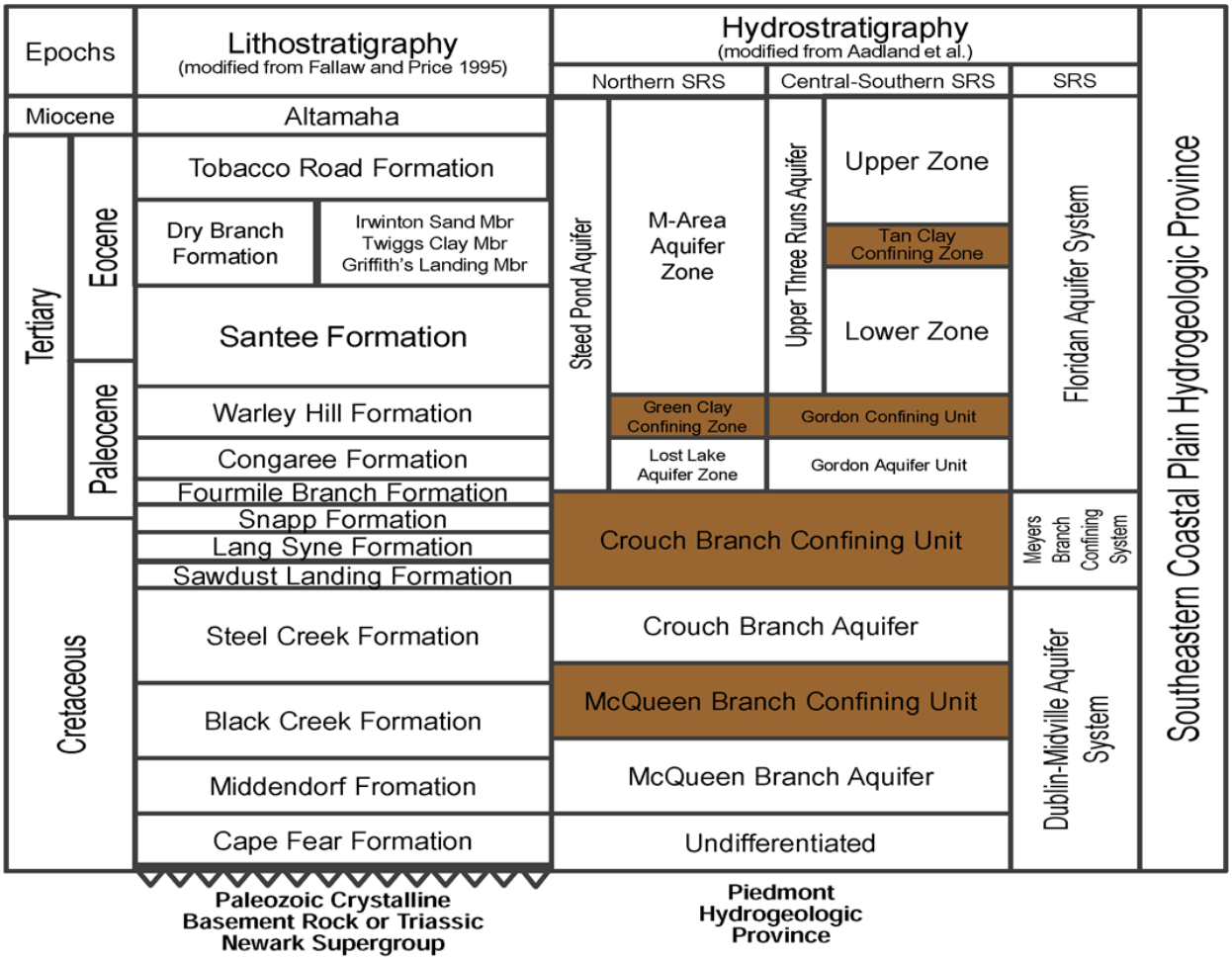


Figure 9 Lithostratigraphic and Hydrostratigraphic Comparisons at SRS

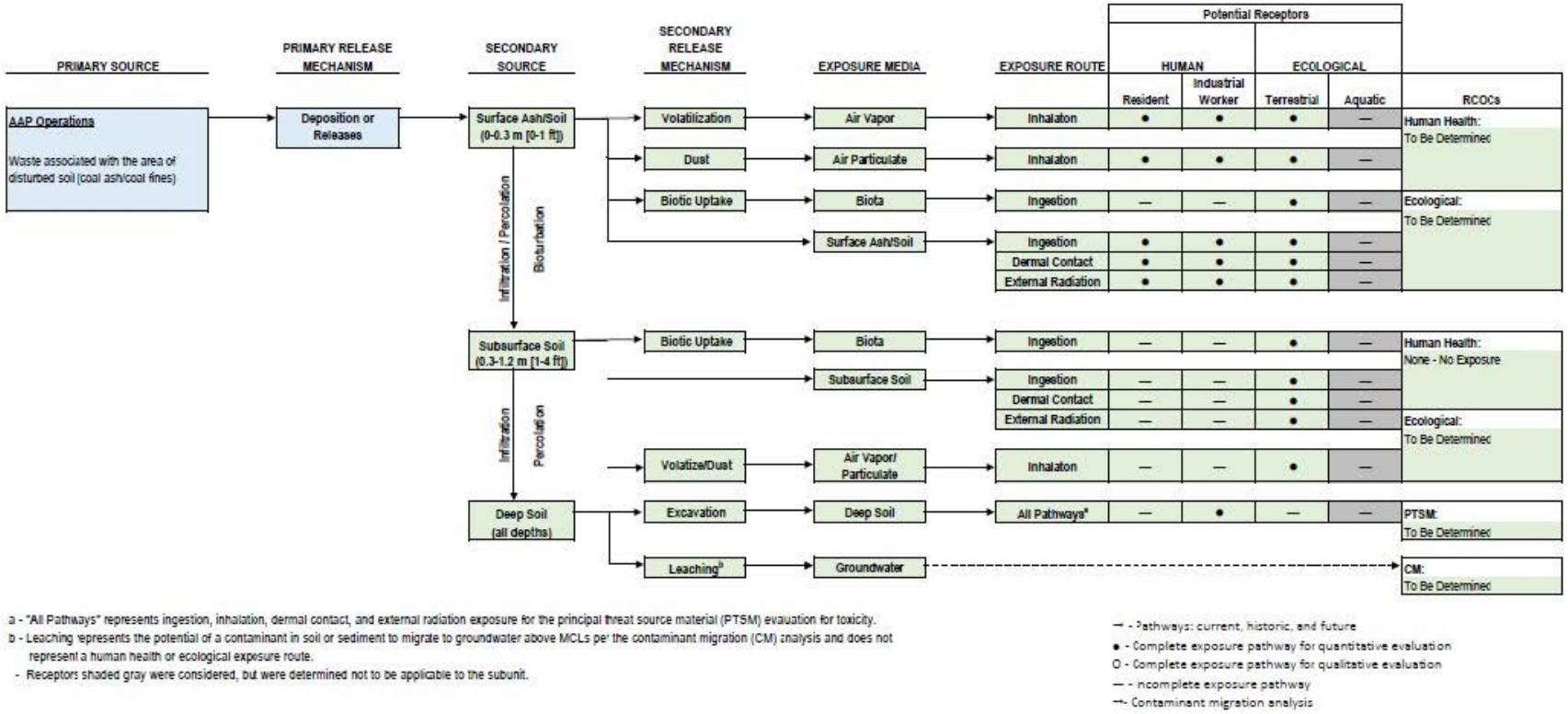


Figure 10 Preliminary CSM for the A-Area Ash Pile

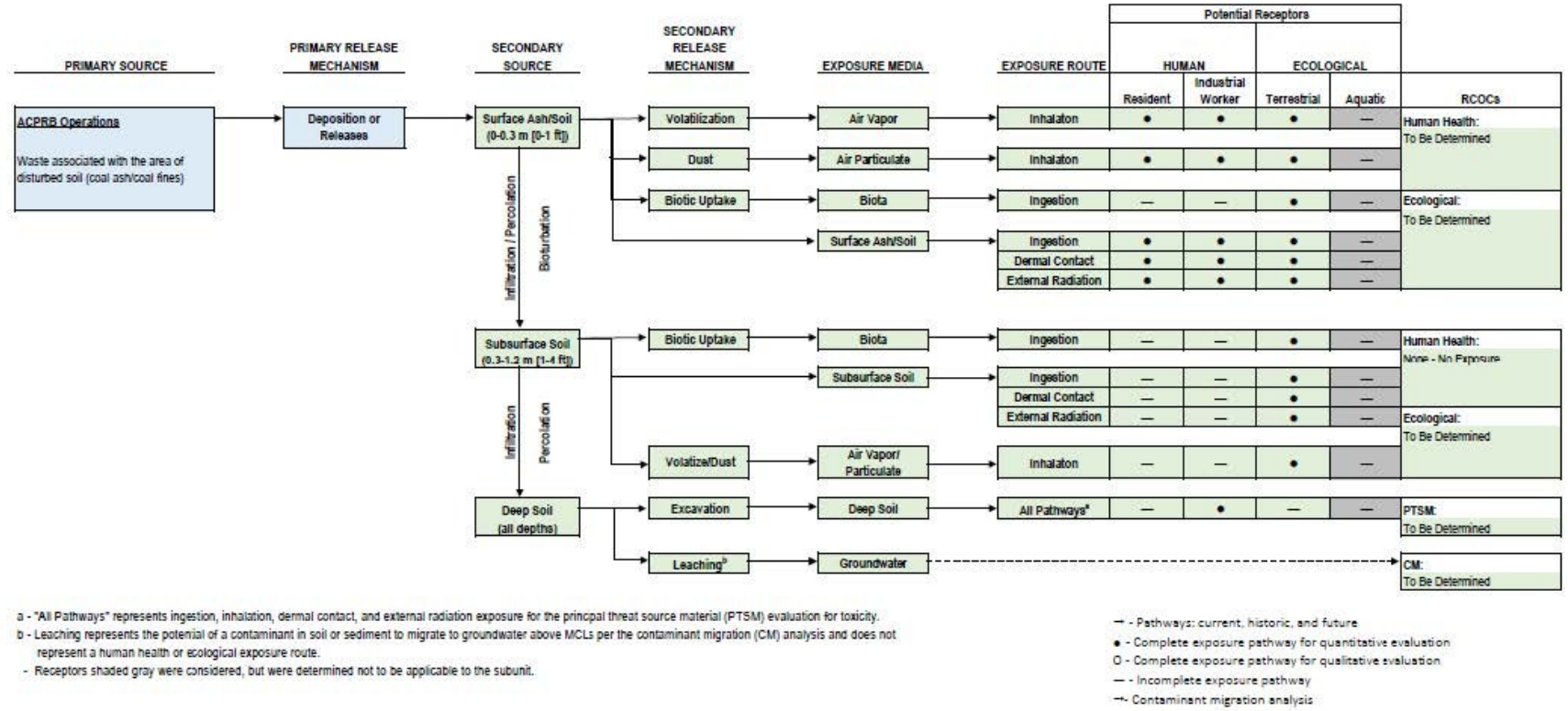


Figure 11 Preliminary CSM for the A-Area Coal Pile Runoff Basin

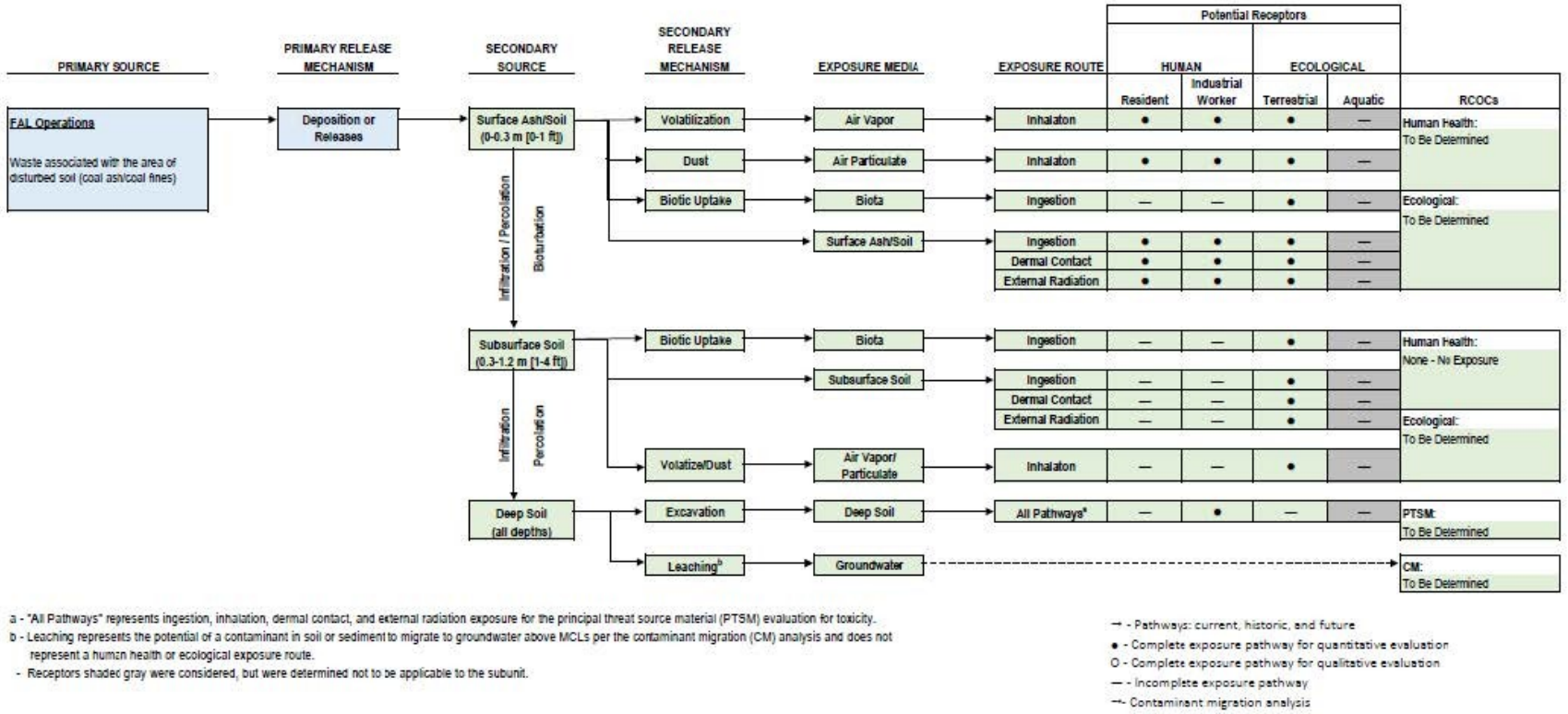


Figure 12 Preliminary CSM for F-Area Ash Landfill OU

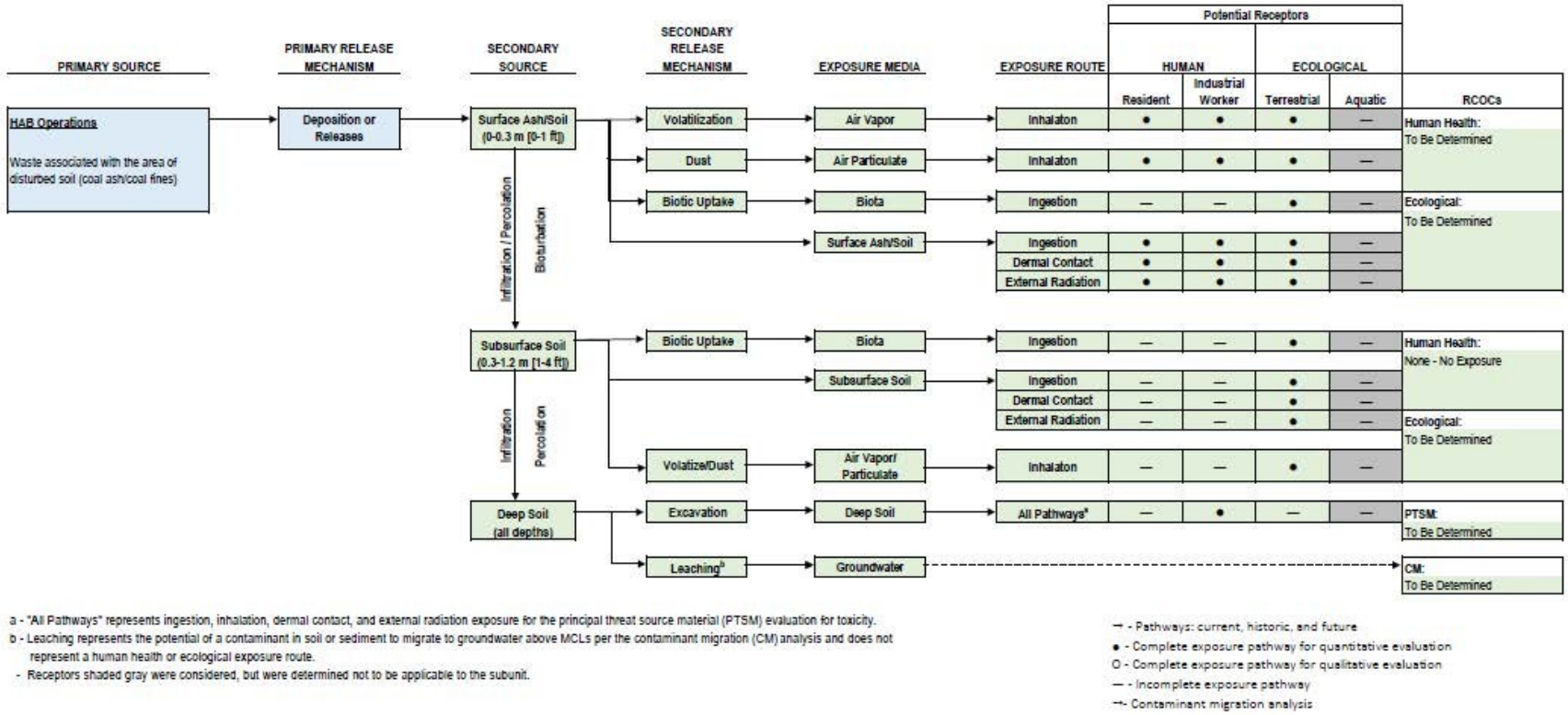


Figure 13 Preliminary CSM for H-Area Ash Basin OU

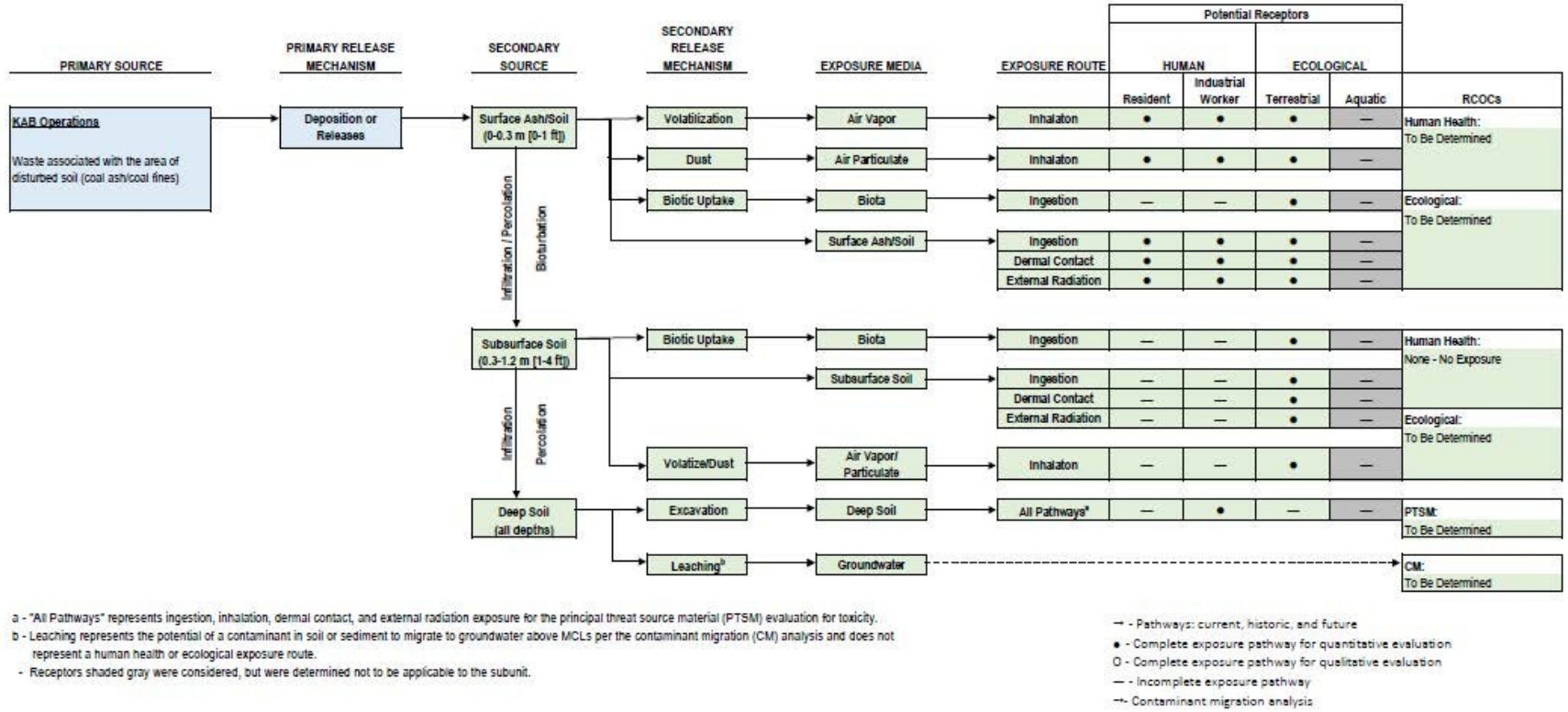


Figure 14 Preliminary CSM for K-Area Ash Basin OU

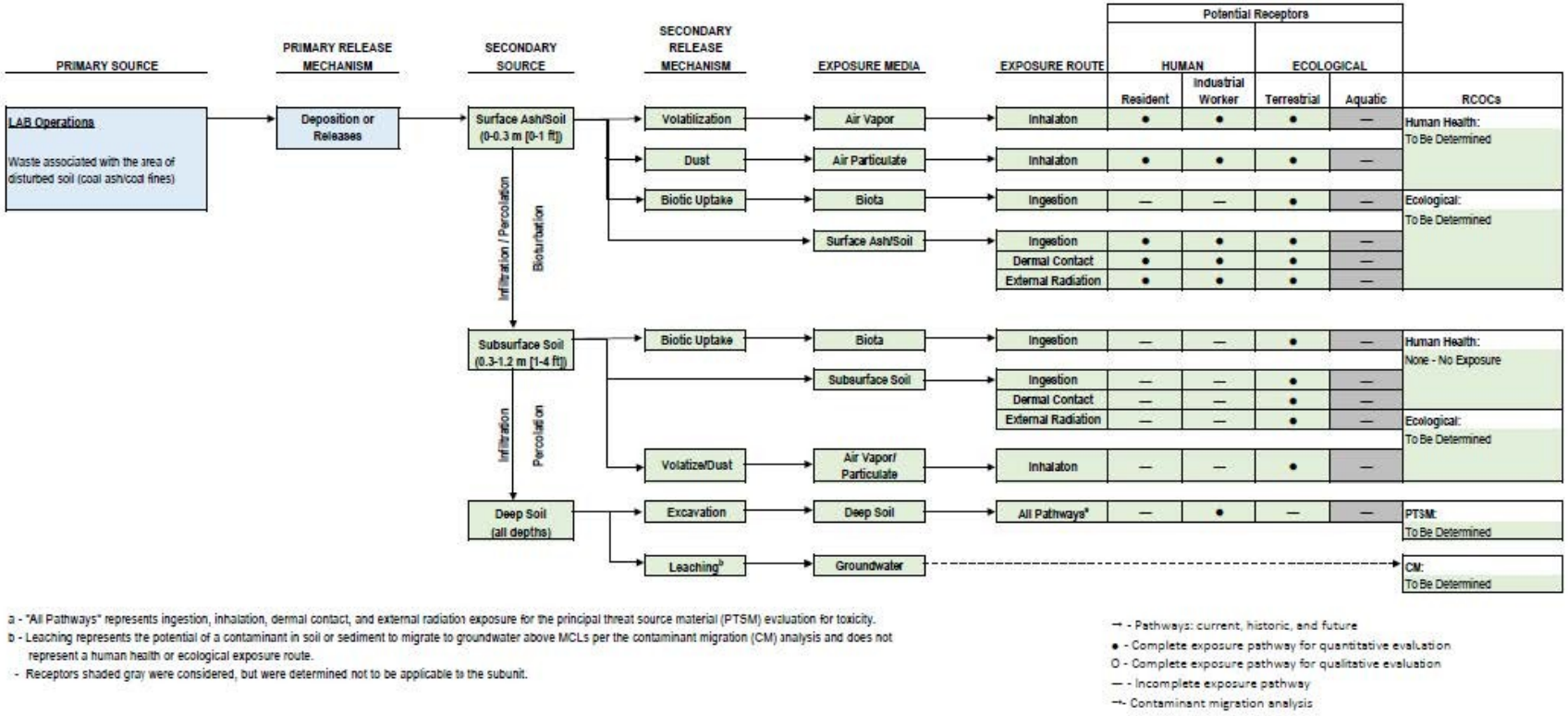


Figure 15 Preliminary CSM for L-Area Ash Basin OU

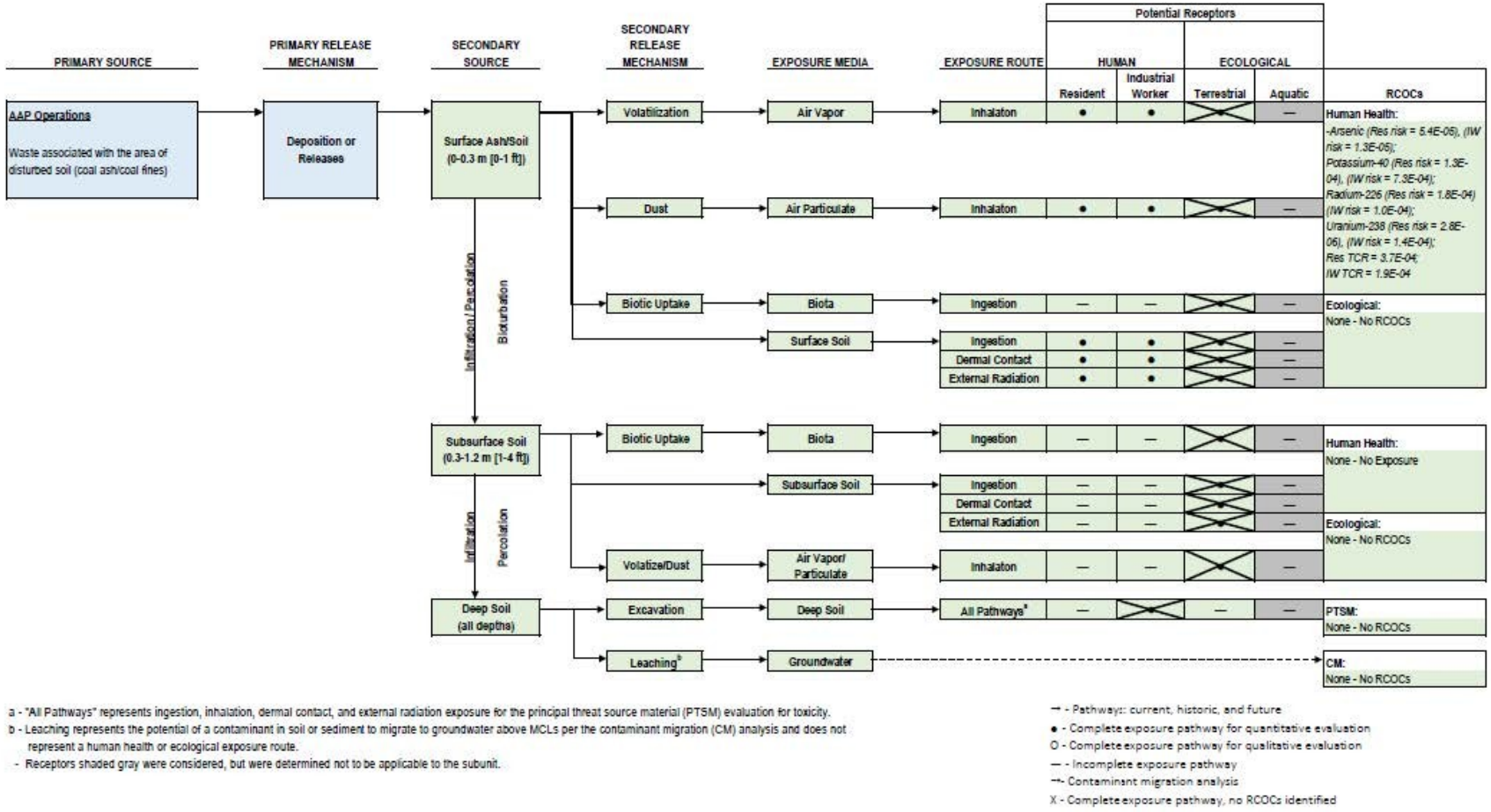


Figure 16 Refined CSM for the A-Area Ash Pile

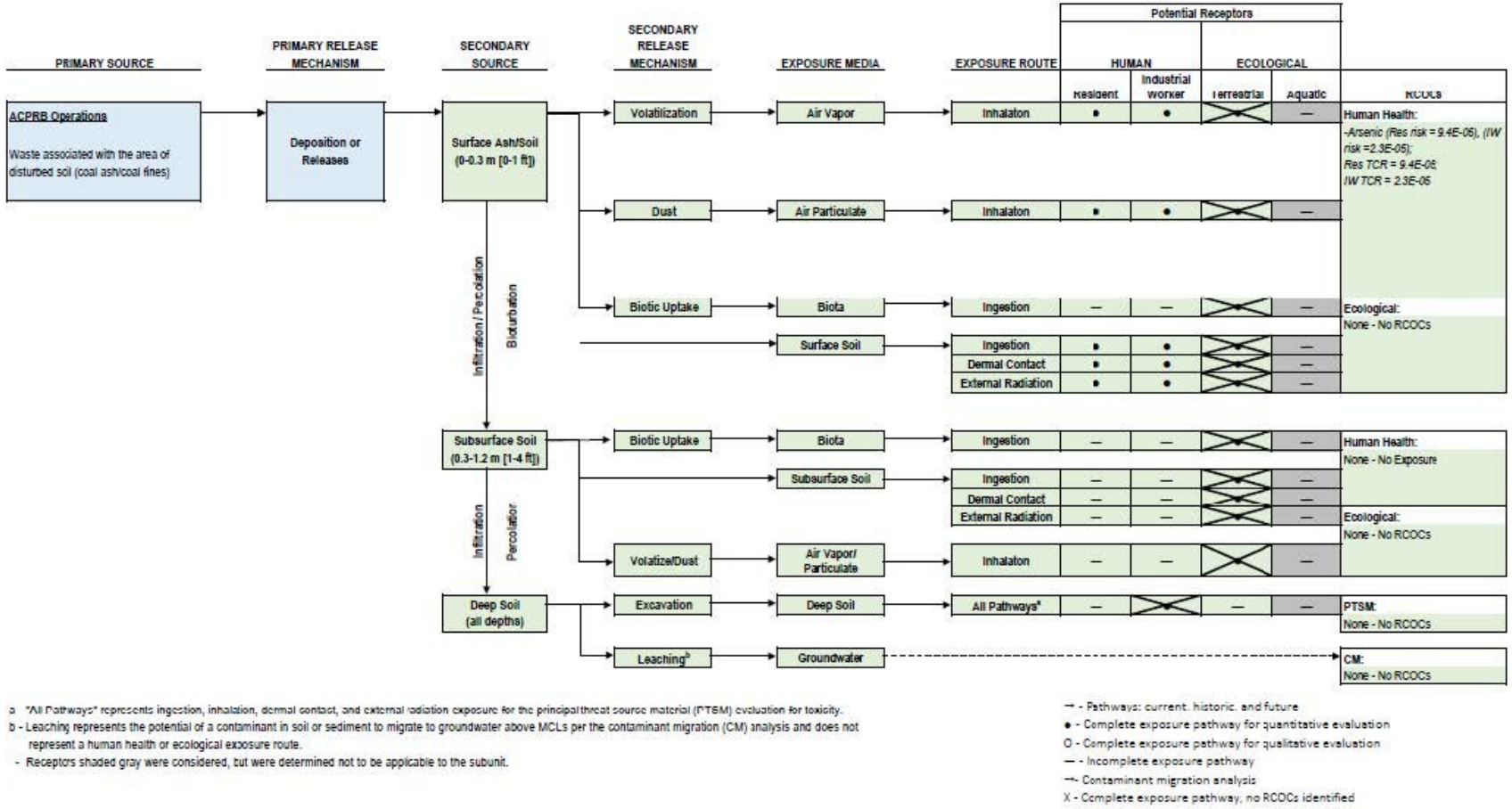


Figure 17 Refined CSM for the A-Area Coal Pile Runoff Basin

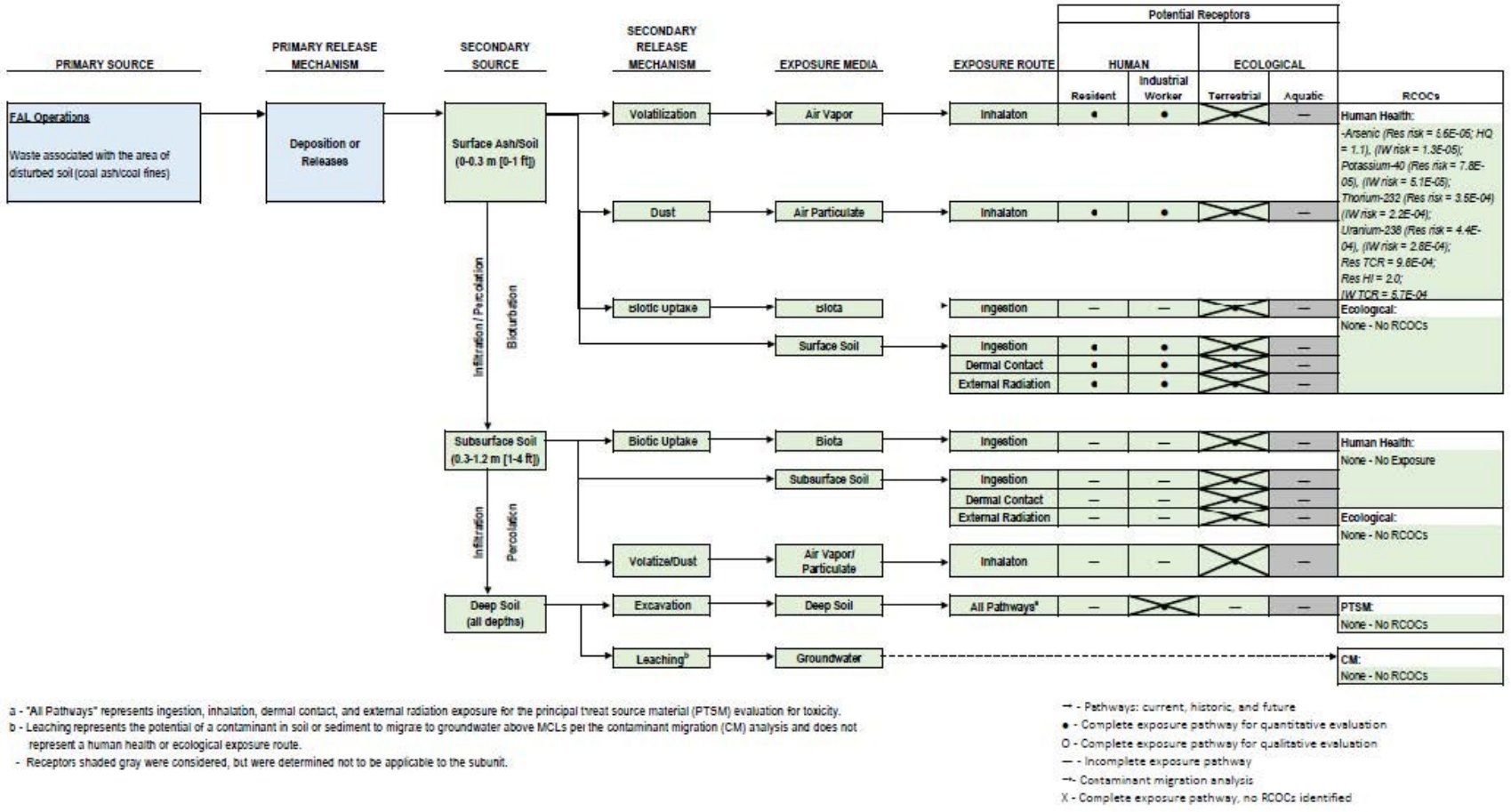


Figure 18 Refined CSM for F-Area Ash Landfill OU

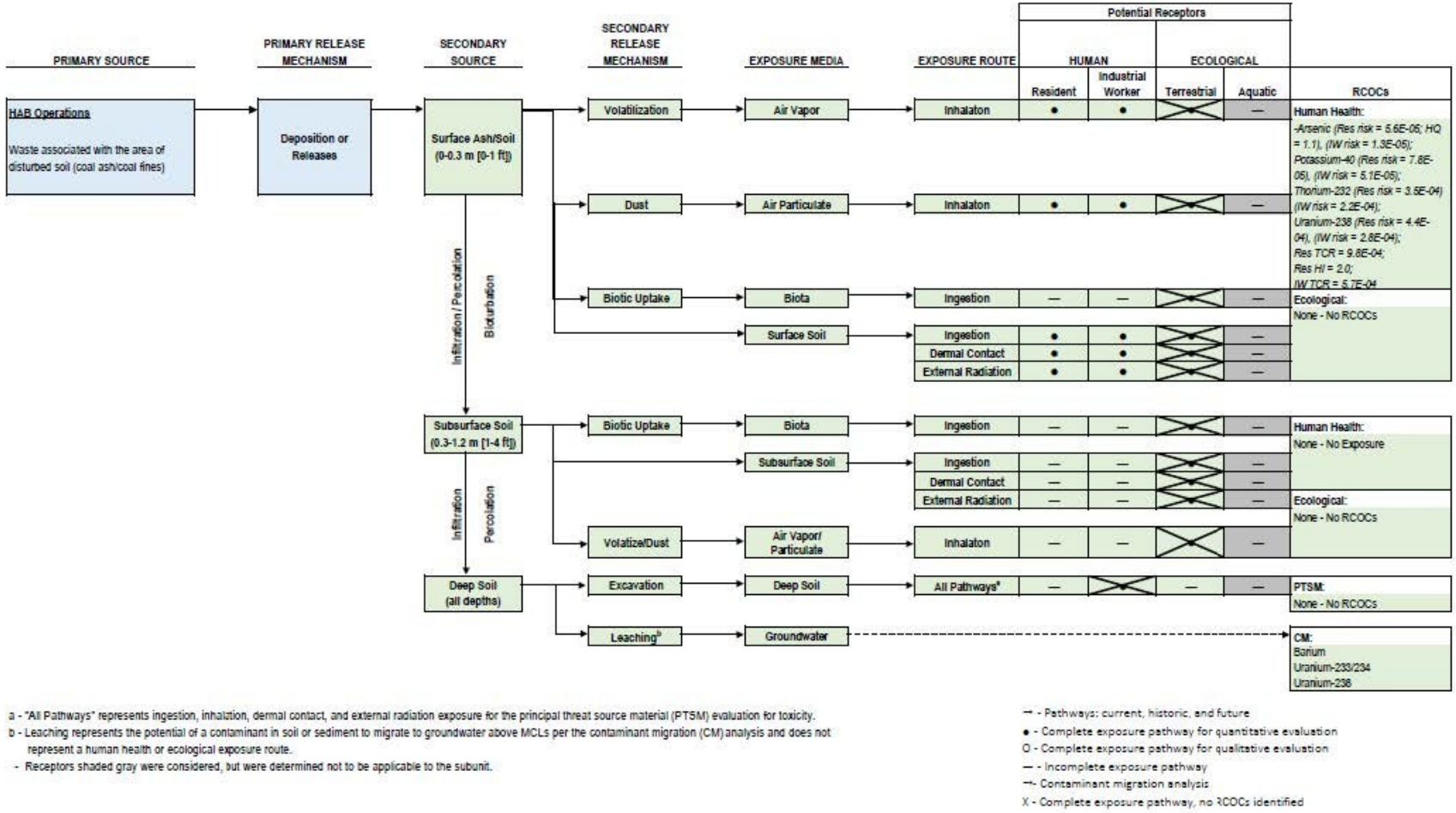


Figure 19 Refined CSM for H-Area Ash Basin OU

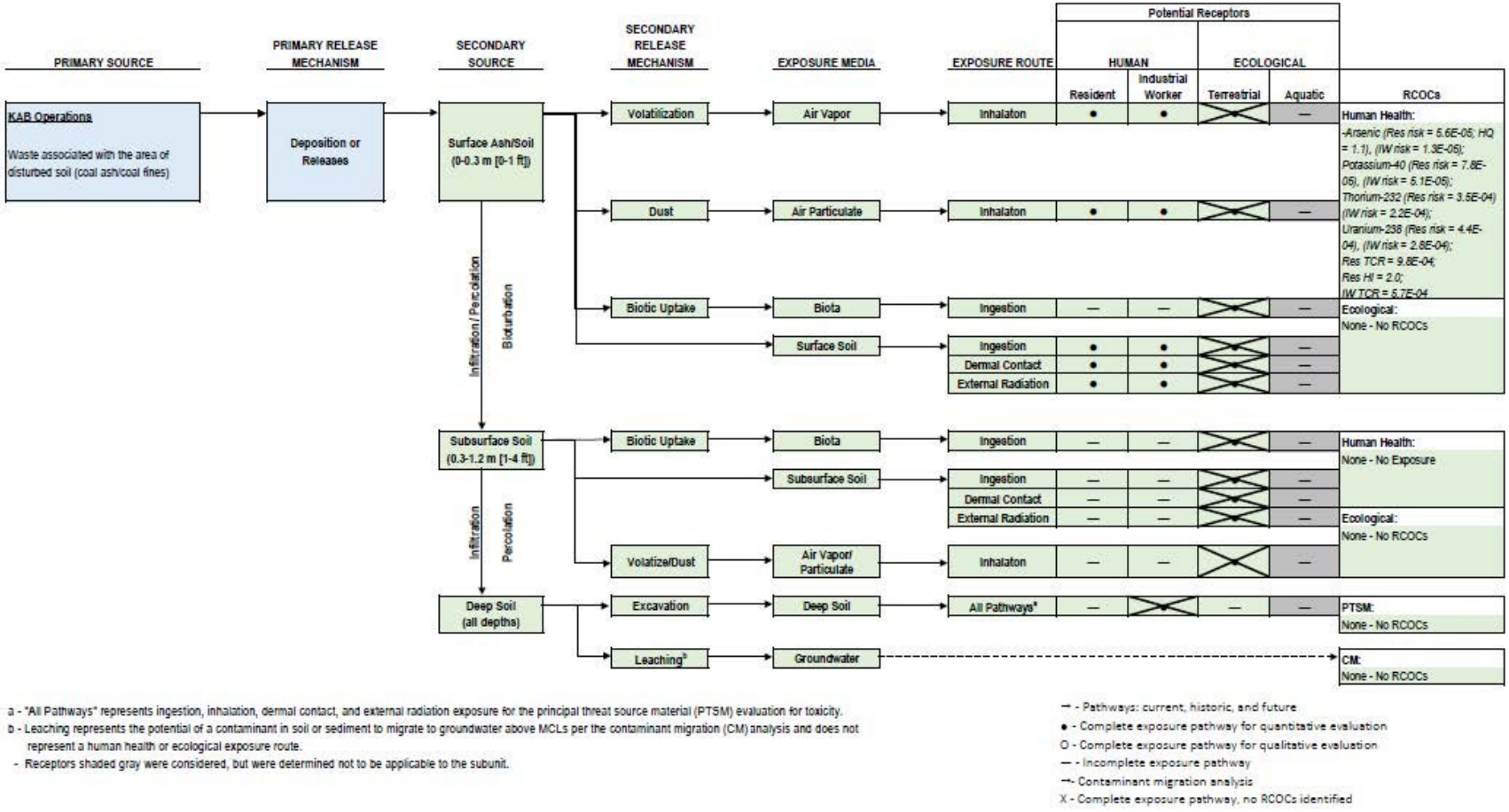


Figure 20 Refined CSM for K-Area Ash Basin OU

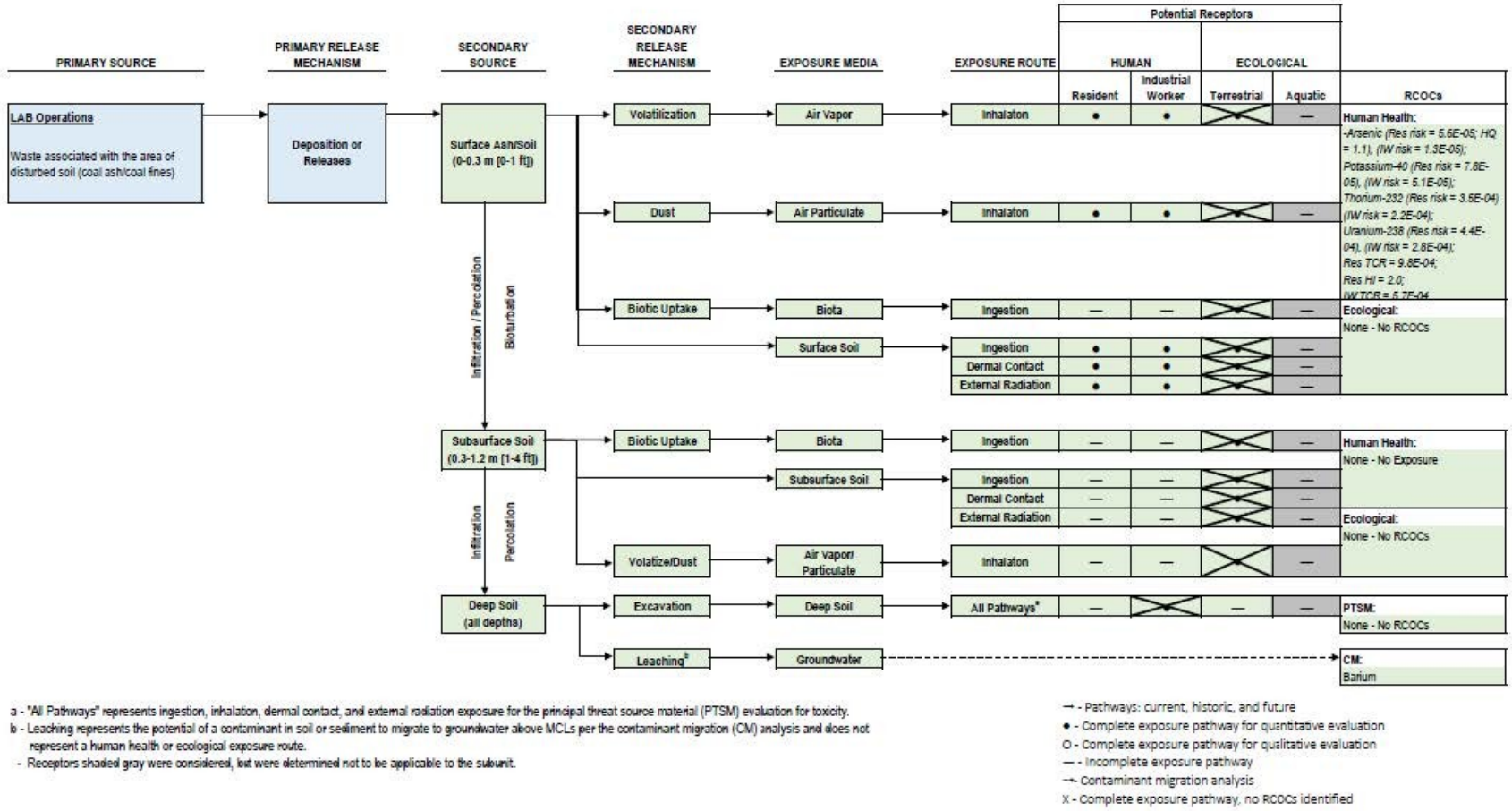


Figure 21 Refined CSM for L-Area Ash Basin OU

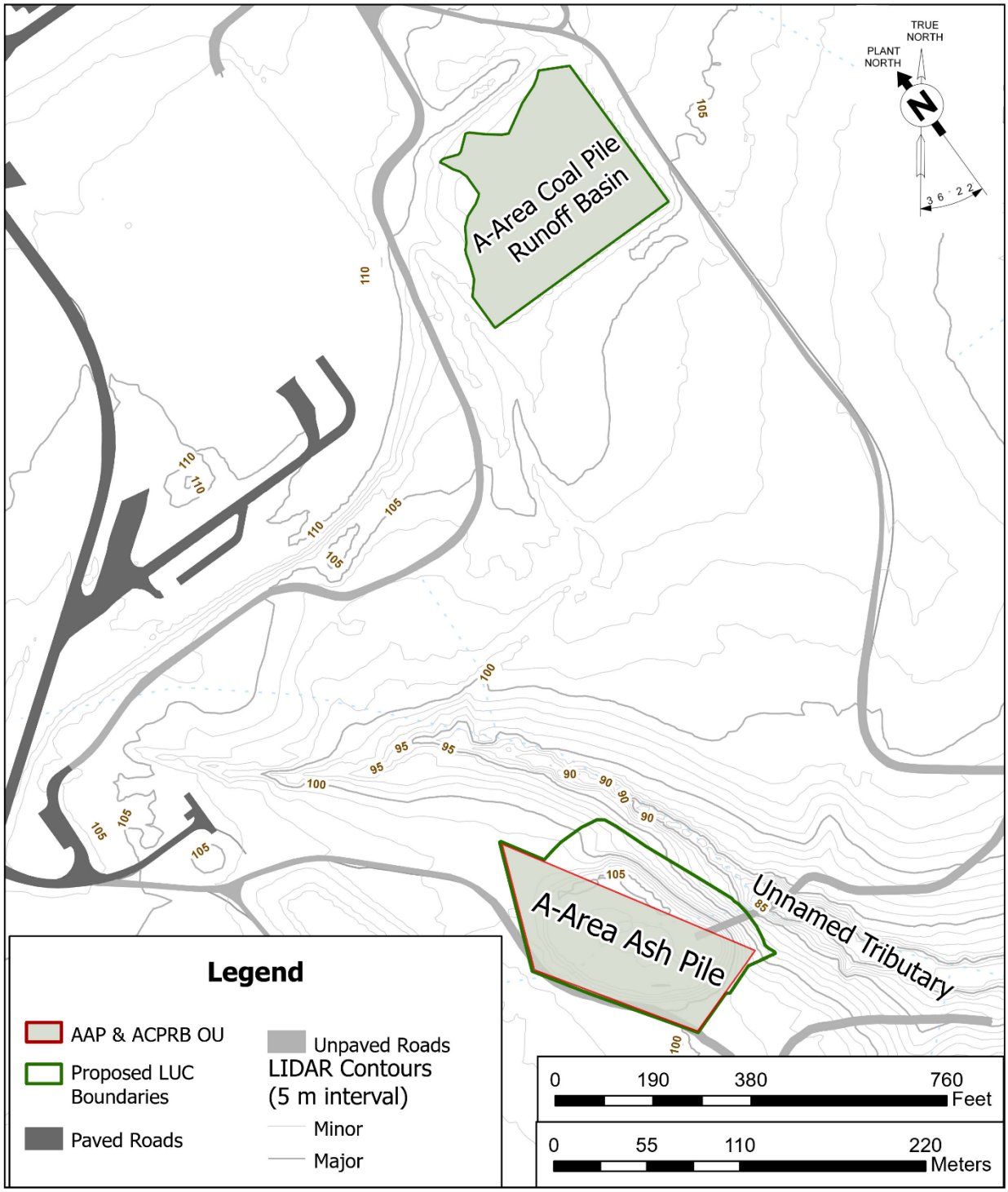


Figure 22 Proposed Land Use Control Boundary for the A-Area Ash Pile and A-Area Coal Pile Runoff Basin OU

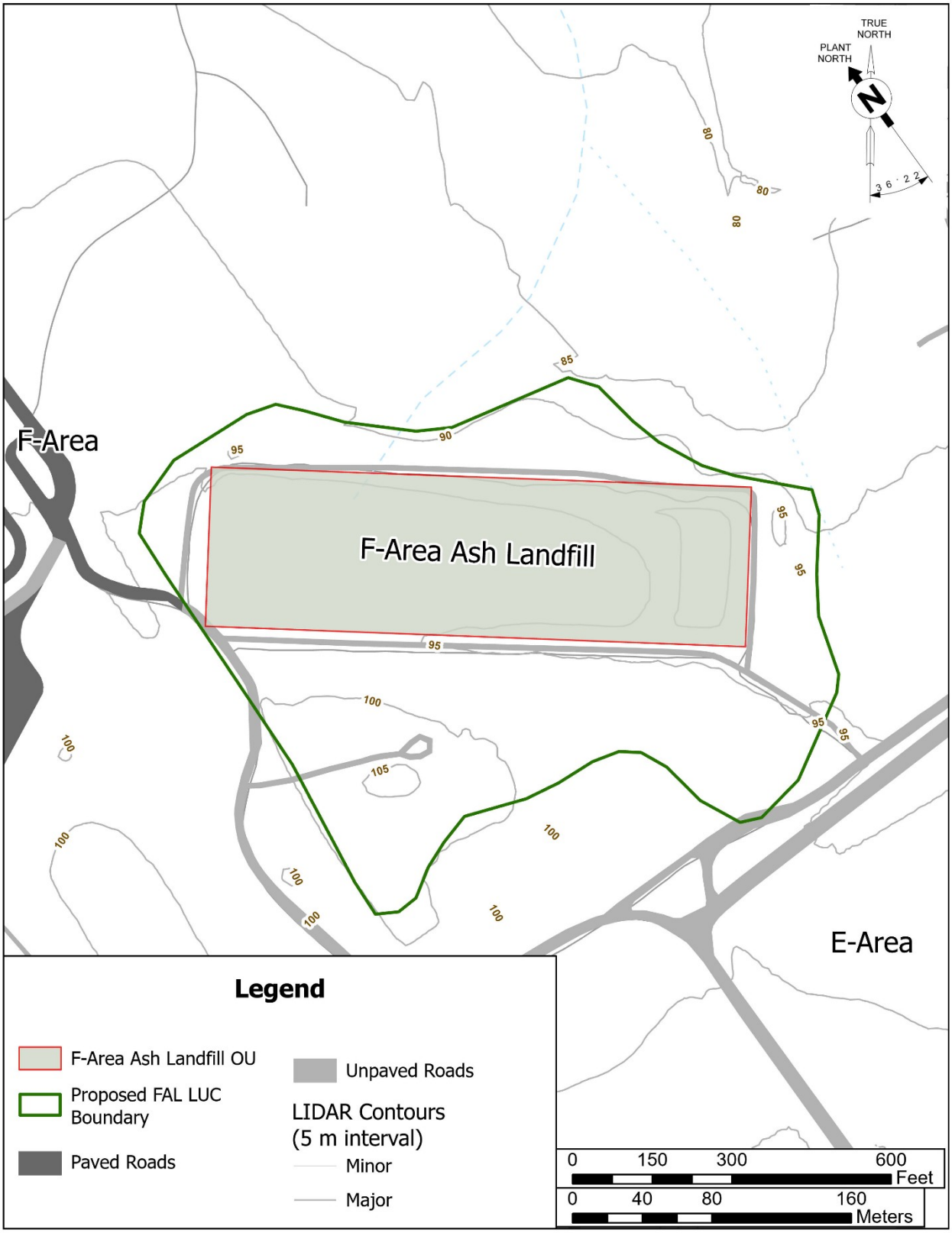


Figure 23 Proposed Land Use Control Boundary for the F-Area Ash Landfill OU

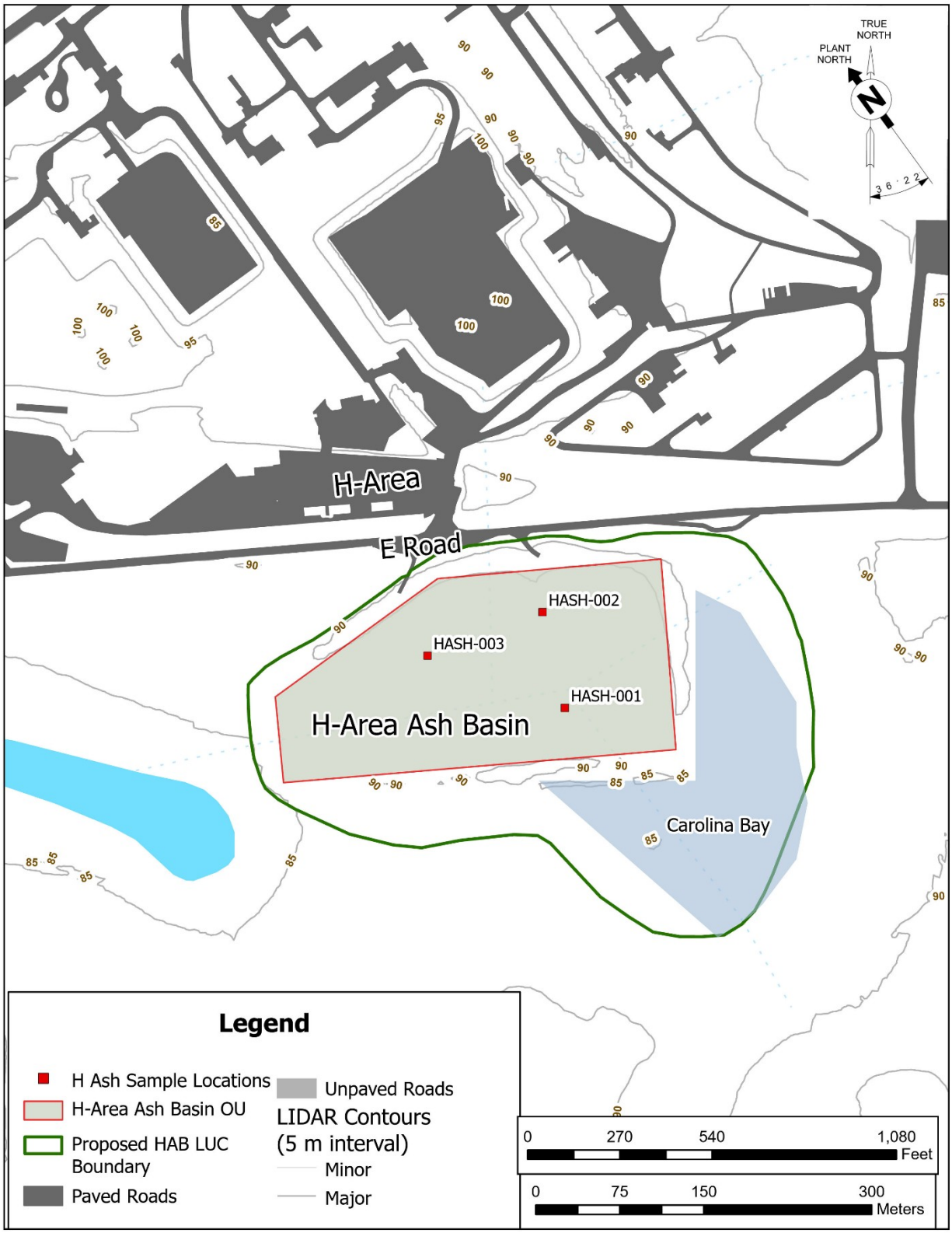


Figure 24 Proposed Land Use Control Boundary for the H-Area Ash Basin OU

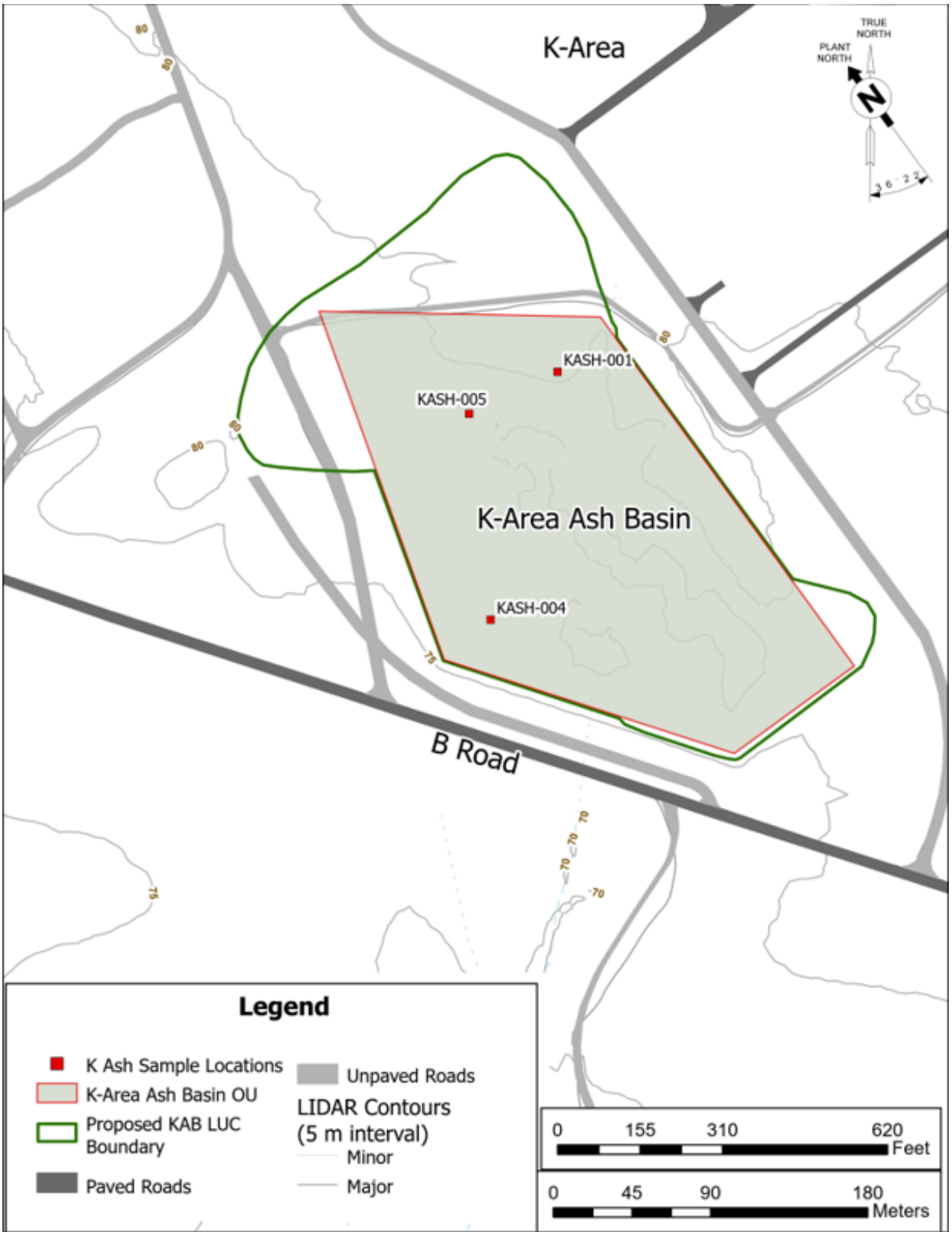


Figure 25 Proposed Land Use Control Boundary for the K-Area Ash Basin OU

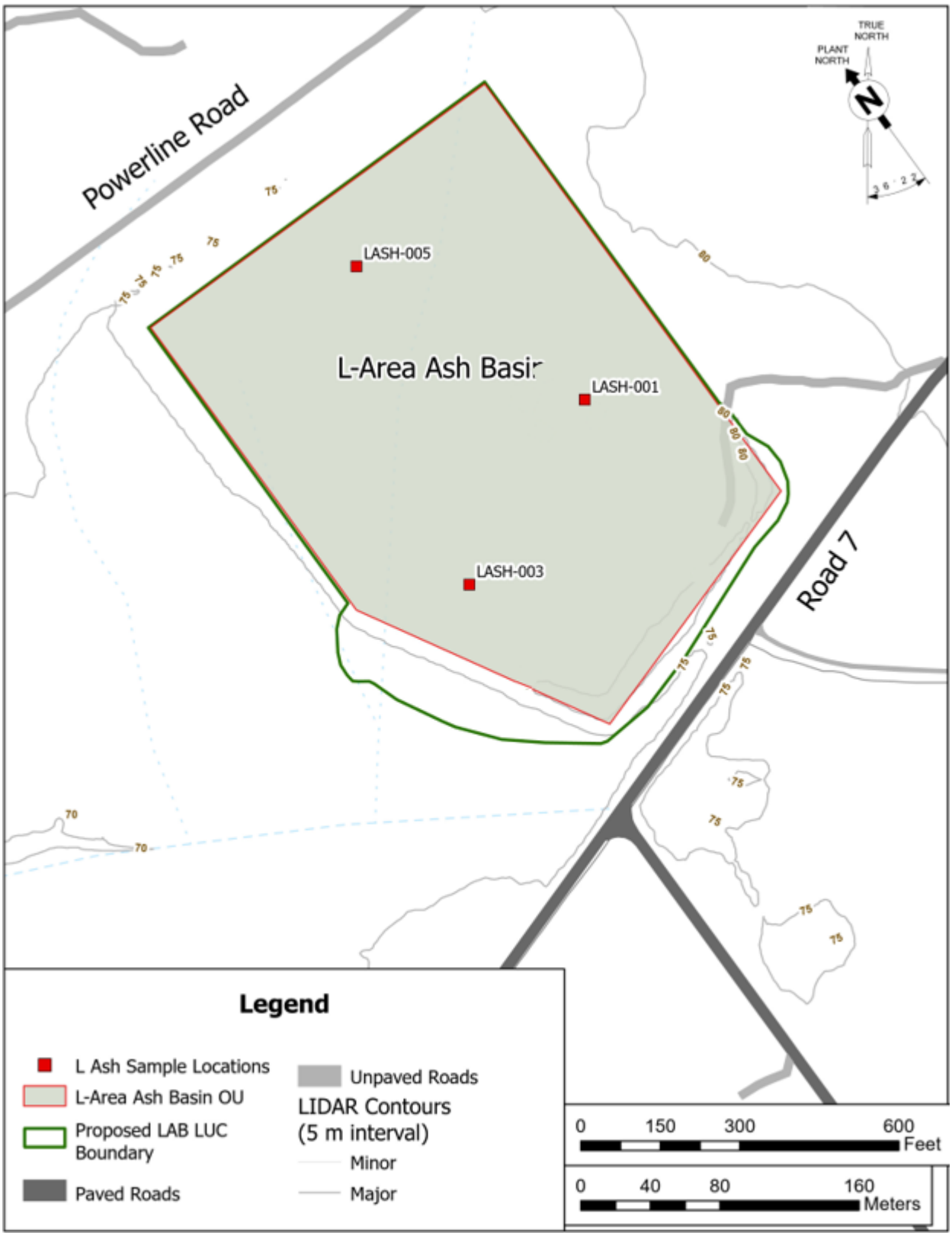


Figure 26 Proposed Land Use Control Boundary for the L-Area Ash Basin OU

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Table 1. Waste Unit Comparison of Arsenic Concentrations and Naturally Occurring Radionuclide Activities

HH COC	***Units***	***SRS Bkgd***	***PAB***	***RAB***	***DCPRB***	***WADB***	***AAP***	***ACPRB***	***HAB***	***KAB***	***LAB***	***FAL***
As	mg/kg	22.9	59.7	28.7	158	33.6	51.6	44.7	**76.5**	**32.3**	**19.1**	**36.3**
K-40	pCi/g	8.53	13.8	16.9	NA	16.4	23.9	NA	**11.3**	**12.5**	**10.8**	**na**
Ra-228 (+D)	pCi/g	6.75	4.07	NA	NA	NA	NA	NA	**4.15**	**2.91**	**2.63**	**na**
Th-228 (+D)	pCi/g	4.17	3.94	NA	NA	NA	NA	NA	**4.27**	**3.94**	**3.18**	**na**
U-238 (+D)	pCi/g	1.9	5.29	8.32	NA	2.51	2.68	NA	**3.59**	**3.7**	**5.82**	**na**
Ra-226 (+D)	pCi/g	1.74	5.4	8.08	NA	2.38	3.33	NA	**4.04**	**4.12**	**8.63**	**na**
U-235 (+D)	pCi/g	0.17	NA	0.506	NA	NA	NA	NA	**ND**	**ND**	**0.561**	**na**

RSL/PRG = USEPA Regional Screening Level / Preliminary Remediation Goal set at risk = 1E-06
SRS Bkgd = *Background Soils Statistical Summary Report for Savannah River Site*, Appendix B-2 (max detect, all depths)
PAB = P-Area Ash Basin
RAB = R-Area Ash Basin
DCPRB = D-Area Coal Pile Runoff Basin
WADB = Wetland Area at Dunbarton Bay
AAP = A-Area Ash Pile
ACPRB = A-Area Coal Pile Runoff Basin
HAB = H-Area Ash Basin
KAB = K-Area Ash Basin
LAB = L-Area Ash Basin
FAL = F-Area Ash Landfill
na = not analyzed
NA = not applicable
ND = not detected

Table 2. Summary Table of Tier I and Tier II Screening Results

OU Subunit	# of Tier I CM COPCs	Tier I CM COPCs	Tier II CM COCs	CM RCOCs
HAB OU	17	Benzo(a)anthracene, Naphthalene, Aluminum, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	Barium, Nickel, Uranium-233/234, Uranium-235, Uranium-238	Barium, Uranium-233/234, Uranium-235 Uranium-238
KAB OU	16	Benzo(a)anthracene, Naphthalene, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	None	None
LAB OU	16	Benzo(a)anthracene, Naphthalene, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	Barium, Nickel	Barium
FAL OU	17	Benzo(a)anthracene, Naphthalene, Aluminum, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	None	None

Table 3. Summary of the RCOCs for the Remaining Coal Ash and Coal Fines OUs

Subunit	RCOCs					
			HHRA			
	ARAR	CM [1]	Residential	Industrial	ERA	PTSM
AAP	Ash / Soil **None**	Ash / Soil **None**	Ash / Soil *Arsenic =5.4E-05* *Potassium-40 = 1.3E-04* *Radium-226 [2] = 1.8E-04* *Uranium-238 = 2.8-06* **TCR = 3.7E-04**	Ash / Soil *Arsenic = 1.3E-05* *Potassium-40 = 7.3E-04* *Radium-226 [2] =1.0E-04* *Uranium-238 = 1.4E-06* **TCR = 1.9E-04**	Ash / Soil **None**	Ash / Soil **None**
ACPRB	Ash / Soil **None**	Ash / Soil **None**	Ash / Soil *Arsenic = 9.4E-05* **TCR = 9.4E-05**	Ash / Soil *Arsenic =2.3E-05* **TCR = 2.3E-05**	Ash / Soil *None*	Ash / Soil **None**
FAL	Ash / Soil None	Ash / Soil None	Ash / Soil Arsenic = 5.6E-05; HQ = 1.1 Potassium-40 = 7.8E-05 Thorium-232 = 3.5E-04 Uranium-238 = 4.4E-04 HI = 2.0 TCR = 9.8E-04	Ash / Soil Arsenic = 1.3E-05 Potassium-40 = 5.1E-05 Thorium-232 = 2.2E-04 Uranium-238 = 2.8E-04 TCR = 5.7E-04	Ash / Soil None	Ash / Soil None

Table 3. Summary of the RCOCs for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

HAB	Ash / Soil **None**	Ash / Soil ***Barium*** *= 5.64E+03 ug/L (402 years)* ***Uranium-233/234*** *= 5.04E+01 pCi/L (845 years)* ***Uranium-235*** **=** *4.05E+00 pCi/L (845 years)* ***Uranium-238*** *= 5.01E+01 (845 years)*	Ash / Soil *Arsenic = 5.6E-05; HQ = 1.1* *Potassium-40 = 7.8E-05* *Thorium-232 = 3.5E-04* *Uranium-238 = 4.4E-04* **HI = 2.0** **TCR = 9.8E-04**	Ash / Soil *Arsenic = 1.3E-05* *Potassium-40 = 5.1E-05* *Thorium-232 = 2.2E-04* *Uranium-238 = 2.8E-04* **TCR = 5.7E-04**	Ash / Soil **None**	Ash / Soil **None**
KAB	Ash / Soil **None**	Ash / Soil **None**	Ash / Soil *Arsenic = 5.6E-05; HQ = 1.1* *Potassium-40 = 7.8E-05* *Thorium-232 = 3.5E-04* *Uranium-238 = 4.4E-04* **HI = 2.0** **TCR = 9.8E-04**	Ash / Soil *Arsenic = 1.3E-05* *Potassium-40 = 5.1E-05* *Thorium-232 = 2.2E-04* *Uranium-238 = 2.8E-04* **TCR = 5.7E-04**	Ash / Soil **None**	Ash / Soil **None**
LAB	Ash / Soil **None**	Ash / Soil *Barium = 4.80E+03 ug/L (638 years)*	Ash / Soil *Arsenic = 5.6E-05; HQ = 1.1* *Potassium-40 = 7.8E-05* *Thorium-232 = 3.5E-04* *Uranium-238 = 4.4E-04* **HI = 2.0** **TCR = 9.8E-04**	Ash / Soil *Arsenic = 1.3E-05* *Potassium-40 = 5.1E-05* *Thorium-232 = 2.2E-04* *Uranium-238 = 2.8E-04* **TCR = 5.7E-04**	Ash / Soil **None**	Ash / Soil **None**

Table 3. Summary of the RCOCs for the Remaining Coal Ash and Coal Fines OUs *(Continued/End)*

1) Contaminant Migration RCOCs present the predicted groundwater concentration and the mean travel time to groundwater impact.
2) Radium-226 risk will be managed under the cleanup level established for the entire decay series. Radium-226 is a daughter product of the uranium-238 decay series.

AAP = A-Area Ash Pile

ACPRB = A-Area Coal Pile Runoff Basin

ARAR = applicable or relevant and appropriate requirement

CM = contaminant migration

ERA = ecological risk assessment

FAL = A-Area Ash Landfill

HAB = H-Area Ash Basin

HHRA = human health risk assessment

KAB = K-Area Ash Basin

LAB = L-Area Ash Basin

PTSM = principal threat source material

RCOCs = refined constituents of concern from RFI/RI/BRA
TCR = total cumulative risk

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs

LOCATION-SPECIFIC ARARs/TBC					
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**	**Alt -2**	**Alt-3**
Floodplains and Wetlands					
Presence of wetlands as defined in 10 *CFR* 1022.4	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands and floodplains.	DOE actions that involve potential impacts to, or take place within, wetlands – **applicable.**	10 *CFR* 1022.3(a)	✓	✓
	Take action, to extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.		10 *CFR* 1022.3(a)(7) and (8)	✓	✓
	Undertake a careful evaluation of the potential effects of any new construction in wetlands. Identify, evaluate, and as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands.		10 *CFR* 1022.3(b) and (d)	✓	✓
	If no practicable alternative to locating or conducting the action in the wetland is available, then before taking action, design or modify the action in order to minimize potential harm to or within the wetland, consistent with the policies set forth in E.O. 11990.		10 *CFR* 1022.14(a)	✓	✓
Location encompassing *aquatic ecosystem* as defined in 40 CFR 230.3(c)	No discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact. No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with 40 CFR 230.70 *et seq.* have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable.**	40 CFR 230.10(a) 40 CFR 230.10(d)	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

LOCATION-SPECIFIC ARARs/TBC					
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**	**Alt -2**	**Alt-3**
Floodplains and Wetlands					
Location encompassing *aquatic ecosystem* as defined in 40 CFR 230.3(c)	No discharge of dredged or fill material into an aquatic ecosystem is permitted if there is a practicable alternative that would have less adverse impact. No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with 40 CFR 230.70 *et seq.* have been taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable.**	40 CFR 230.10(a) 40 CFR 230.10(d)	✓	✓
	Must comply with the substantive requirements of the NWP 38, General Conditions, as appropriate, any regional or case-specific conditions recommended by the Corps District Engineer, after consultation. Note: Despite that consultation may be considered an administrative requirement, it should be performed to ensure activities are in compliance with substantive provisions of the permit.	On-site CERCLA action conducted by Federal agency that involves discharge of dredged or fill material into *waters of the United States*, including jurisdictional wetlands – **relevant and appropriate**.	Nationwide Permit (38) – Cleanup of Hazardous and Toxic Waste 33 *CFR* 323.3(b)	✓	✓
Presence of wetlands	Requires Federal agencies to evaluate action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Actions that involve potential impacts to, or take place within, wetlands – **TBC**	Executive Order 11990 – *Protection of Wetlands* - Section 1.(a)	✓	✓
Presence of migratory birds and their habitats	No person may take, possess, import, export, transport, sell, purchaser, barter or offer for sale, purchase or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit.	If action is likely to impact migratory birds – **applicable**.	16 *USC* 703-704 – Migratory Bird Treaty Act	✓	✓
Presence of archeological or cultural artifacts	No person may excavate, remove, damage, or otherwise alter or deface, or attempt to excavate, remove, damage, or otherwise alter or deface any archaeological resource located on public lands unless such activity is pursuant to a permit issued under § 7.8 or exempted by § 7.5(b) of this part. *Note: Prior to removal activities existing Site Use process requires approval by the Savannah River Archaeological Research Program. The SRARP is a division of the South Carolina Institute of Archaeology and Anthropology (SCIAA) at the University of South Carolina. The SRARP manages the archaeological and other historic resources for the U.S. Department of Energy.*	Excavation and/or removal of archaeological resources from public lands – **applicable**.	43 *CFR* Part 7 – implementing the Archaeological Resources Protection Act of 1979.	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

ACTION SPECIFIC ARARs/TBC					
Action	**Requirements**	**Prerequisite**	**Citation**	**Alt-2**	**Alt-3**
General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)					
Managing storm water run-off from land-disturbing activities	Must comply with the substantive requirements for stormwater management and sediment control of *NPDES General Permit No. SCR100000.*	Large and small construction activities (as defined in R.61-9) of more than 1 acre of land – **applicable**	SC R.61-9.122.26(c) NPDES General Permit No. SCR100000	✓	✓
	The requirements of R.72-305 and R.72-307 will apply.	For land disturbing activities disturbing more than five (5) acres – **applicable**	SC R.72-305.B.(3)	✓	✓
	The stormwater management and sediment control plan shall contain at a minimum the information provided in the following subsections:	Activities involving more than two (2) acres and less than five (5) acres of actual land disturbance which are not part of a larger common plan of development or sale – **applicable**	SC R.72-307 I. – *South Carolina Storm Water Management and Sediment Reduction Regulations*	✓	✓
	A plan for temporary and permanent vegetative and structural erosion and sediment control measures which specify the erosion and sediment control measures to be used during all phases of the land disturbing activity and a description of their proposed operation.		SC R.72-307 I.(3)(d)	✓	✓
	Provisions for stormwater runoff control during the land disturbing activity and during the life of the facility meeting the following requirements: 1. Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2- and 10-year frequency 24-hour duration storm event. Implementing agencies may utilize a less frequent storm event (e.g. 25-year, 24-hour) to address existing or future stormwater quantity or quality problems. 2. Discharge velocities shall be reduced to provide a non-erosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbing activity, whichever is greater.		SC R.72-307 I.(3)(e)	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
***General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.**(cont'd)*					
Managing fugitive dust emissions from land disturbing activities	Emissions of fugitive particulate matter shall be controlled in such a manner and to the degree that it does not create an undesirable level of air pollution. Volatile organic compounds shall not be used for dust control purposes. Oil treatment is also prohibited.	Activities that will generate fugitive particulate matter (Statewide) – **applicable**	SC R.61-62.6 Section III(a)-*Control of Fugitive Particulate Matter Statewide* SC R.61-62.6 Section III(d)	✓	✓
Waste Characterization and Storage — (e.g., wastewaters, excavated ash, coal fines, contaminated soils/sediments, vegetation, debris)					
Characterization of *solid* waste	Must determine if solid waste is a hazardous waste using the following method: Should first determine if waste is excluded from regulation under 40 CFR 261.4; and	Generation of solid waste as defined in 40 CFR 261.2 – **applicable**	40 CFR 262.11(a) SC R.61-79 262.11*(a)*	✓	✓
	Must determine if waste is listed as hazardous waste under 40 CFR Part 261.	Generation of solid waste which is not excluded under 40 CFR 261.4(a) – **applicable**	40 CFR 262.11(b) SC R.61-79 262.11*(b)*	✓	✓
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR Part 261 by either: 1. Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or 2. Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.	Generation of solid waste which is not excluded under 40 CFR 261.4(a) – **applicable**	40 CFR 262.11(c) SC R.61-79 262.11*(c)*	✓	✓
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be *hazardous* waste – **applicable** (Note: Coal ash and coal pile runoff are excluded as hazardous, solid waste per 40 CFR 261.4(b)(4)(i) and (ii)).	40 CFR 262.11(d) SC R.61-79 262.11*(d)*	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Waste Characterization and Storage — (e.g., wastewaters, excavated ash, coal fines, contaminated soils/sediments, vegetation, debris) *(cont'd)*					
Determinations for management of *hazardous* waste [1]	Must determine each EPA Hazardous Waste Number (waste code) applicable to the waste in order to determine the applicable treatment standards under 40 CFR 268 *et seq.* *Note:* This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter.	Generation of hazardous waste for storage, treatment or disposal – **applicable**	40 CFR 268.9(a) SC R.61-79 268.9*(a)*	✓	✓
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the characteristic waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment, or disposal – **applicable**	40 CFR 268.9(a) SC R.61-79 268.9*(a)*	✓	✓
	Must determine if the hazardous waste meets the treatment standards in 40 CFR 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste. *Note:* This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11.	Generation of hazardous waste for storage, treatment or disposal – **applicable**	40 CFR 268.7(a) SC R.61-79 268.7 *(a)* (1)	✓	✓
Temporary Storage of Solid Waste	Shall be conducted in a manner to: a. Inhibit the harborage of flies, rodents, and other vectors; b. Prevent conditions for transmission of diseases to man or animals; c. Prevent blowing debris and particulates so as not to be injurious to human health and the environment; d. Prevent water pollution and prevent the escape of solid waste or leachate to waters of the State; and Minimize objectionable odors, dust, unsightliness, and aesthetically objectionable conditions, and prevent the accumulation of materials in an untidy and unsafe manner so as to become a fire and safety hazard.	Generation of solid waste for temporary storage prior to processing, disposal of that waste – **relevant and appropriate**	SC R.61-107.5(C)(1)	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Disposal of Wastes In Ash Basin or Off-Site (e.g., ash, coal fines, contaminated soils/sediments, vegetation, debris)					
Off-Site Disposal of Solid Waste	Shall ultimately dispose of solid waste at facilities and/or sites permitted or registered by the Department for processing or disposal of that waste stream.	Generation of solid waste intended for off-site disposal – **relevant and appropriate**	SC R.61-107.5(D)(3)		✓
Off-site Disposal of RCRA-*Hazardous* Waste in a Land-Based Unit [1]	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste – **applicable**	40 CFR §268.40(a) SC R.61-79 268.40*(a)*		✓
	All underlying hazardous constituents [as defined in 40 CFR 268.2(i)] must meet the Universal Treatment Standards (UTSs), found in 40 CFR 268.48 Table UTS prior to land disposal.	Land disposal of restricted RCRA characteristic wastes (D001-D043) not managed in a wastewater treatment system regulated under the Clean Water Act (CWA), that is CWA equivalent, or that is injected into a Class I nonhazardous injection well – **applicable**	40 CFR §268.40(e) SC R.61-79 268.40*(e)*		✓
	Must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or Must be treated according to the UTSs [specified in 40 CFR 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils –**applicable**	40 CFR §268.49(b) SC R.61-79 268.49*(b)*		✓
	To determine whether a hazardous waste identified in this section exceeds the applicable treatment standards of 40 CFR 268.40, the initial generator must test a sample of the waste extract or the entire waste, depending on whether the treatment standards are expressed as concentration in the waste extract or waste, or the generator may use knowledge of the waste. If the waste contains constituents (including underlying hazardous constituents [UHCs] in the characteristic wastes) in excess of the applicable UTS levels in 40 CFR 268.48, the waste is prohibited from land disposal, and all requirements of Part 268 are applicable, except as otherwise specified.	Land disposal of RCRA toxicity characteristic wastes (D004-D011) that are newly identified – **applicable**	40 CFR 268.34(f) SC R.61-79 268.34*(f)*		✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Dewatering of Ash Basin (If Necessary – no basins currently hold water)					
Discharge to Surface Water	Any discharge into waters of the State must be permitted by the Department and receive a degree of treatment and/or control which shall produce an effluent which is consistent with the Act, the Clean Water Act (P.L. 92-500, 95-217, 97-117, 100-4), this regulation, and related regulations. *Note:* Under CERCLA Section 121(e) permits are not required for on-site response actions. Instead, SRS must meet any applicable effluent limits in its existing NPDES discharge permit or other substantive requirements, including the numeric water quality criteria for the protection and maintenance of the appropriate class of surface waters as adopted in SC R.61-68 and listed in Sections E, G, and the appendix therein.	Discharge of pollutants (including toxic substances) into waters of the State of South Carolina – **applicable**	SC R.61-68E.4.a SC R.61-68 E.14	✓	✓
	Site-specific permit effluent limitations and alternate criteria less stringent than those derived in accordance with the requirements in SC R.61-68 E.14.c. may be derived where it is demonstrated that such limits and criteria shall maintain the existing and classified uses.		SC R.61-68 E.14.c.(7)	✓	✓
	Discharge of garbage, cinders, ashes, oils, sludges, or other refuse is not allowed.	Quality Standards for Waters of the State of South Carolina (classified as FW as provided in SC R.61-68G.10) – **applicable**	SC R.61-68G.10.a	✓	✓
	Treated wastes, toxic wastes, deleterious substances in sufficient amounts to make the waters unsafe or unsuitable for primary contact recreation or to impair the waters for any other best usage are not allowed.		SC R.61-68G.10.b	✓	✓
	Discharge of toxic pollutants is not allowed except as prescribed in Section E of SC R.61-68.		SC R.61-68G.10.c	✓	✓
	Stormwater, and other nonpoint source runoff is allowed if water quality necessary for existing and classified uses shall be maintained and protected consistent with anti-degradation rules.		SC R.61-68G.10.d	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Dewatering of Ash Basin (If Necessary – no basins currently hold water)					
	Dissolved oxygen – daily average not less than 5.0 mg/L with a low of 4.0 mg/L		SC R.61-68G.10.e	✓	✓
	pH between 6.0 and 8.5		SC R.61-68G.10.g	✓	✓
Monitoring Well Installation, Operation, and Abandonment					
Installation or Abandonment of Permanent and Temporary Monitoring Wells	All monitoring wells shall be drilled, constructed, maintained, operated, and/or abandoned to ensure that underground sources of drinking water are not contaminated.	Construction of permanent and temporary monitoring wells (including non-standard installation, as defined in R.61-71B(2)) – – **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	SC R.61-71H.1(b) SC R.61-71H.2(e)		✓
On-Site Closure/Capping of Ash Basins					
Closure of CCR Unit	Closure of a CCR landfill, CCR surface impoundment, or any lateral expansion of a CCR unit must be completed either by leaving the CCR in place and installing a final cover system or through removal of the CCR and decontamination of the CCR unit,	Closure of CCR Unit– **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	40 CFR 257.102 (a) SC R.61-107.19 Part V		✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
On-Site Closure/Capping of CCR Unit *(cont'd)*					
Performance Standard when leaving CCR in place	(1) The owner or operator of a CCR unit must ensure that, at a minimum, the CCR unit is closed in a manner that will: (i) Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere; (ii) Preclude the probability of future impoundment of water, sediment, or slurry; (iii) Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period; (iv) Minimize the need for further maintenance of the CCR unit	Closure of CCR disposal facility– **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	40 CFR 257.102(d)(1) SC R.61-107.19 Part V		✓
	(2) Drainage and stabilization of CCR surface impoundments. The owner or operator of a CCR surface impoundment or any lateral expansion of a CCR surface impoundment must meet the requirements of paragraphs (d)(2)(i) and (ii) of this section prior to installing the final cover system required under paragraph (d)(3) of this section. (i) Free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues. (ii) Remaining wastes must be stabilized sufficient to support the final cover system.	Closure of CCR disposal facility– **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	40 CFR 257.102(d)(2) SC R.61-107.19 Part V		✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
On-Site Closure/Capping of CCR Unit *(cont'd)*					
Performance Standard when leaving CCR in place	(3) Final cover system. If a CCR unit is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and at a minimum, meets the requirements of paragraph (d)(3)(i) of this section (i) The final cover system must be designed and constructed to meet the criteria in paragraphs (d)(3)(i)(A) through (D) of this section. The design of the final cover system must be included in the written closure plan required by paragraph (b) of this section. (A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 × 10−5 cm/sec, whichever is less. (B) The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material. (C) The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth. (D) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.	Closure of CCR disposal facility– **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	40 CFR 257.102(d) (3) SC R.61-107.19 Part V		✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Groundwater Monitoring Systems					
Performance Standard when leaving CCR in place	(a) The owner or operator of a CCR unit must install a groundwater monitoring system that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield groundwater samples from the uppermost aquifer that: (1) Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the CCR management area where: (i) Hydrogeologic conditions do not allow the owner or operator of the CCR unit to determine what wells are hydraulically upgradient; or (ii) Sampling at other wells will provide an indication of background groundwater quality that is as representative or more representative than that provided by the upgradient wells; and (2) Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary that ensures detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.	Groundwater monitoring requirements for CCR left in place. **relevant and appropriate**	40 CFR 257.91 (a)		✓
	(b) the number, spacing, and depths of monitoring systems shall be determined based upon site-specific technical information that must include thorough characterization of: (1) Aquifer thickness, groundwater flow rate, groundwater flow direction including seasonal and temporal fluctuations in groundwater flow; and (2) Saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.	Groundwater monitoring requirements for CCR left in place. **relevant and appropriate**	40 CFR 257.91 (b)		✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Groundwater Monitoring Systems cont.					
	(c)The groundwater monitoring system must include the minimum number of monitoring wells necessary to meet the performance standards specified in paragraph (a) of this section, based on the site-specific information specified in paragraph (b) of this section. The groundwater monitoring system must contain: (1) A minimum of one upgradient and three downgradient monitoring wells; and (2) Additional monitoring wells as necessary to accurately represent the quality of background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit.	Groundwater monitoring requirements for CCR left in place. **relevant and appropriate**	40 CFR 257.91 (c)		✓
	(e) Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater.	Groundwater monitoring requirements for CCR left in place. **relevant and appropriate**	40 CFR 257.91 (e)		✓
Post-Closure of Ash Basins					
Post-Closure Care Requirements	Following closure, owner/operator must conduct post-closure care for a minimum of 30 years, except as provided in paragraph b. below, and consistent of at least the following: Maintain the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover.	Post-closure care of solid waste disposal facility (SC Class III landfill) – **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	40 CFR 258.61(a)(1),(3) SC R.61-107.19 Part V Subpart F 258.61(a)		✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
***Post-Closure of s Ash Basins** (cont'd)*					
Post-Closure Groundwater Monitoring	Monitoring the groundwater in accordance with the requirements of subpart E of this Part and maintaining the groundwater monitoring system. *Note:* USDOE will conduct post-closure groundwater monitoring and reporting under the respective Operable Unit to document the effectiveness of the cover system. The length of the post-closure care period may be decreased if the permittee can provide technical rationale that the decreased post-closure care period is sufficient to protect human health and the environment. *Note:* USDOE as part of the CERCLA remedy review process (including Five-Year Review under Section 121(c)), must seek SCDES and USEPA approval of a modification to the monitoring period.	Post-closure care of solid waste disposal facility (SC Class III landfill) – **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	SC R.61-107.19 Part V Subpart F 258.61(a)(3) 40 CFR 258.61(b)(2) SC R.61-107.19 Part V Subpart F 258.61(b)(2)		✓
Post-closure use of Property	Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this Part. *Note:* USDOE is responsible for ensuring LUCs (as part of the CERCLA remedy) to prevent unauthorized activities including disturbance of landfill cover integrity. LUCs will be implemented as part of the final remedial action for the DAOU.	Post-closure care of solid waste disposal facility (SC Class III landfill) – **relevant and appropriate** **(NOTE: "Applicable" for 288-F only since it is a SCDES permitted landfill.)**	SC R.61-107.19 Part V Subpart F 258.61(c)(3)		✓
Transportation of Wastes					
Transportation of Samples (i.e. Solid Waste, Soils and Wastewaters)	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when: • the sample is being transported to a laboratory for the purpose of testing; or • the sample is being transported back to the sample collector after testing. • the sample is being stored by sample collector before transport to a lab for testing.	Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition – **applicable**	40 CFR 261.4(d)(1)(i)-(iii) SC R.61-79 261.4*(d)* (1)	✓	✓

Table 4. Potential ARARs and TBC Criteria for the Remaining Coal Ash and Coal Fines OUs *(Continued/End)*

Action	Requirements	Prerequisite	Citation	Alt-2	Alt-3
Transportation of Wastes *(cont'd)*					
	In order to qualify for the exemption in 40 CFR 261.4 (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements. • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.		40 CFR 261.4(d)(2)(i) 40 CFR 261.4(d)(2)(i)(A) and (B) SC R.61-79 261.4*(d)* (2)(i)(A) and (B)	✓	✓
Managing Fugitive Dust Emissions from Land-Disturbing Activities	Emissions of fugitive particulate matter shall be controlled in such a manner and to the degree that it does not create an undesirable level of air pollution. Volatile organic compounds shall not be used for dust control purposes. Oil treatment is also prohibited.	Activities that will generate fugitive particulate matter (Statewide) – Applicable	SCDES R. 61-62.6 Section III(a)- Control of Fugitive Particulate Matter Statewide SCDES R. 61-62.6 Section III(d)	✓	✓

1 - The requirements from 40 CFR Part 268 contained in this table will be triggered if any generated wastes, including coal ash, coal fines, soil, sediments, and/or groundwater are characterized as RCRA *hazardous* wastes.

Alt	=	Alternative	NPDES	=	National Pollutant Discharge Elimination System
ARAR	=	applicable or relevant and appropriate requirement	POLYM	=	Polymerization
CFR	=	*Code of Federal Regulations*	RCRA	=	Resource Conservation and Recovery Act of 1976
CMBST	=	Combustion	RORGS	=	Recovery of organics
CCR	=	Coal Combustion Residuals	SCDES	=	South Carolina Department of Environmental Services
CWA	=	Clean Water Act of 1972	TCLP	=	Toxicity Characteristic Leaching Procedure
DEACT	=	deactivation	UHC	=	underlying hazardous constituents
DOT	=	U.S. Department of Transportation	UTS	=	Universal Treatment Standard
EPA	=	U.S. Environmental Protection Agency	WWTU	=	Waste Water Treatment Unit
LDR	=	Land Disposal Restrictions			

Table 5. Summary of the Remaining Coal Ash and Coal Fines Operable Units Cleanup Levels

MEDIA	RCOC[1,14]	UNITS	ARAR[2]	HHRA Future Resident[3] (1.00E-06)	HHRA Industrial Worker[4] (1.00E-06)	HHRA Onsite Worker[5] (1.00E-06)	HHRA Adolescent Trespasser[6] (1.00E-06)	PTSM[7]	ERA[8]	CM[9]	Most Restrictive PRG[10]	SRS Background 95th %tile[11]	Most Likely PRG[12]
AAP (ash)	Arsenic	mg/kg	-	0.68	3.0	6.24	7.1	-	-	-	0.68	*8.2*	8.2
	Potassium-40	pCi/g	-	0.144	0.219	0.446	0.819	-	-	-	0.144	*3.3*	3.3
	Uranium-238	pCi/g	-	0.0125	0.020	0.0416	NA[13]	-	-	-	0.0125	*1.22*	1.22
ACPRB (sediment/ coal fines)	Arsenic	mg/kg	-	0.68	3.0	6.24	7.1	-	-	-	0.68	*8.3*	8.3
ACPRB (surface water)	None	-	-	-	-	-	-	-	-	-	-	-	-
FAL, HAB, KAB, LAB (ash)	Arsenic	mg/kg	-	0.68	3.00	6.24	7.1	-	-	-	0.68	*8.2*	8.2
	Potassium-40	pCi/g	-	0.144	0.219	0.446	0.819	-	-	-	0.144	*3.3*	3.3
	Thorium-232	pCi/g	-	0.00985	0.0153	0.0318	0.0688	-	-	-	0.001	*1.94*	1.94
	Uranium-238	pCi/g	-	0.0125	0.020	0.0416	NA[13]	-	-	-	0.125	*1.22*	1.22
HAB	Barium	mg/ kg	-	-	-	-	-	-	-	*64.1*	64.1	75.3	64.1
	Uranium-233/234	pCi/g	-	-	-	-	-	-	-	0.67	0.67	*1.20*	1.20
	Uranium-235	pCi/g	-	-	-	-	-	-	-	0.03	0.03	*0.11*	0.11
	Uranium-238	pCi/g	-	-	-	-	-	-	-	0.67	0.67	*1.22*	1.22
LAB	Barium	mg/ kg	-	-	-	-	-	-	-	*75.3*	75.3	49.9	75.3
FAL, HAB, KAB, LAB (surface water)	None	-	-					-	-	-	-	-	-
FAL, HAB, KAB, LAB (groundwater)	None	-	-					-	-	-	-	-	-

[1] - RCOC = refined constituent of concern
[2] - ARAR = applicable or relevant and appropriate requirement.
[3] - HHRA = human health risk assessment. PRGs calculated for the future resident at a target risk of 1E-06.
[4] - HHRA = human health risk assessment. PRGs calculated for the future industrial worker at a target risk of 1E-06.
[5] - HHRA = human health risk assessment. PRGs calculated for the onsite worker at a target risk of 1E-06.

[6] - HHRA = human health risk assessment. PRGs calculated for the adolescent trespasser at a target risk of 1E-06.
[7] - PTSM = principal threat source material evaluation. No RCOCs identified (Appendix E).
[8] - ERA = ecological risk assessment. No RCOCs identified (Appendix D).
[9] - CM = contaminant migration analysis. (Appendix B).
[10] - Most Restrictive PRG = the lesser of the ARAR, HHRA, PTSM, ERA and CM PRGs.
[11] - SRS 95th %tile = ninety-fifth percentile from the SRS Background Soils Statistical Summary Report, Appendix B-2 (all depths), dated October 2006
[12] - Most Likely Cleanup Level = the most restrictive risk-based PRG if it is greater than background concentrations. If the most restrictive risk-based PRG is less than SRS background concentrations, then the PRG defaults to the background value. Sources of the PRG s in this column are highlighted in italics in the table.
[13] - NA = not applicable. U-238(+D) not identified as a HH RCOC for the adolescent trespasser receptor scenario.
[14] - Radium-226 risk will be managed under the cleanup level established for the entire decay series. Radium-226 is a daughter product of the uranium-238 decay series.

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Table 6. Summary of the Screening of Technologies for the Remaining Coal Ash and Coal Fines Operable Units

General Response Action	Remedial Technology	Effectiveness	Implementability	Cost	Technology Status
No Action	None	No action is required by National Hazardous Substances Pollution Contingency Plan (NCP) to serve as a baseline against other technologies and alternatives. Not effective in meeting RAOs. .	Requires no implementation. No efforts would be taken to monitor, remove, treat, or otherwise mitigate the potential spread of contaminants	None	Retained
Land Use Controls	Institutional Controls (i.e., Administrative Controls)	Administrative controls provided by SRS Site Use/Site Clearance procedures; work controls; mandatory worker use of health and safety plans; SRS access controls including security procedures; 24-hour surveillance; controlled entry systems; and warning signs at SRS boundary. Effective in restricting land use.	Readily implemented. Compliance with the various controls and programs must be enforced for this technology to effectively deter site entry.	Low	Retained
	Engineering Controls (i.e., Access Controls)	Engineering controls - Installation of barriers and signs for access control. Effective in restricting land use.	Readily implemented. Regular inspections, monitoring, and maintenance of access controls must be implemented for this technology to effectively deter site entry	Low	Retained

Table 6. Summary of the Screening of Technologies for the Remaining Coal Ash and Coal Fines Operable Units (*Continued/End*)

Containment	Low permeability soil cover system or capping	The effectiveness of containment technologies depends upon the materials used and the design and effectiveness of the soil cover. Cover integrity must be maintained for as long as contaminants will persist or until degradation or decay of the contaminants renders them harmless. Maintenance activities include inspections and monitoring for settlement and erosion. Land use controls would be required in conjunction with a containment remedy.	Readily implementable but would require a planned design and confirmation of placement of the soil layer followed by long term O&M of the cover system.	High	Retained
Excavation and offsite disposal	Excavation	Removing contaminated ash media would eliminate exposure of human receptors to contaminants in soil. Short-term exposure is limited to worker construction and implementation. Effective in long term. Exposure is eliminated by removal of contaminated ash/ sediments.	Readily implementable by excavating contaminated ash media and disposing in an approved disposal facility. The earthwork required for excavating the contaminated media is a standard construction practice and readily accomplished.	High	Retained for beneficial reuse.

Table 7 Summary of the Screening of Alternatives for the Remaining Coal Ash and Coal Fines Operable Units

Alternatives	Effectiveness	Implementability	Cost	Status	Comments
A-1 – No Action	Not effective in preventing exposure to on-site worker to contaminated media. Alternative does not treat waste	Not applicable	None	Required	Alternative is required by NCP
A-2 - LUCs with Beneficial Reuse AAP ACPRB FAL HAB KAB LAB	Effective for achieving RAOs; prevents exposure to on-site worker. Does not reduce toxicity, mobility, or volume of waste until beneficial reuse.	Already implemented at SRS; additional measures to be incorporated into Site Use/Site Clearance permits, SSHASPs to protect on-site worker	Medium	Retained	Effective; implementation would allow contaminated media to remain in place where exposure scenarios are still a possibility until beneficial reuse. 5-year remedy reviews and LUCs required until beneficial reuse.
A-3 - Class III Cover with LUCs ACPRB FAL HAB KAB LAB	Effective for achieving RAOs; prevents exposure to on-site worker. Reduces mobility. Does not reduce toxicity, or volume of waste by treatment.	Already implemented at SRS; additional measures to be incorporated into Site Use/Site Clearance permits, SSHASPs to protect on-site worker	High	Retained	Effective; Residual human health risk less than $1x10^{-6}$ or SRS background concentrations; 5-year remedy reviews and LUCs required until risks decrease to allow for unlimited use and unrestricted exposure

Table 8 Comparison of Alternatives to CERCLA Criteria for the Remaining Coal Ash and Coal Fines Operable Units

	A-1	A-2	A-3
Criterion	No Action	LUCs with Beneficial Reuse	Class III Cover with LUCs
Overall Protection			
Human Health	Not protective of the future resident or onsite worker because there are no controls or remediation.	Meets the requirement by limiting exposure to the contaminated media through the use of administrative and engineering controls.	Meets the requirement by placement of a soil cover to eliminate the direct exposure pathways.
Environment	Not protective because contaminants remain in place	Optimally protective of environment because the ash sites are restored to pre-ash conditions.	Protective of environment because the ash sites are isolated from ash.
Compliance with ARARs			
Chemical-Specific	No ARARs exist	No ARARs exist	No ARARs exist
Location-Specific	No ARARs exist	Meets the requirement by limiting exposure to the contaminated media through the use of administrative and engineering controls.	Meets the requirement by placement of a soil cover to eliminate the direct exposure pathways.
Action-Specific	No ARARs exist	Meets the requirement by limiting exposure to the contaminated media through the use of administrative and engineering controls.	Meets the requirement by placement of a soil cover to eliminate the direct exposure pathways.
Long-Term Effectiveness and Performance			
Magnitude of Residual Human Health Risk	Residual human health risk remains above $1x10^{-6}$ or SRS background concentrations	Residual human health risk less than $1x10^{-6}$ or SRS background concentrations; 5-year remedy reviews and LUCs required until beneficial reuse.	Residual human health risk less than $1x10^{-6}$ or SRS background concentrations; 5-year remedy reviews and LUCs required until risks decrease to allow for unlimited use and unrestricted exposure.
Adequacy of Controls	None.	Controls are adequate as long as they are maintained.	Controls are adequate as long as they are maintained.
Permanence	No	LUCs are permanent until beneficial reuse as long as controls are maintained.	Cover system and LUCs are permanent as long as it is maintained

Table 8 Comparison of Alternatives to CERCLA Criteria for the Remaining Coal Ash and Coal Fines Operable Units (*Continued*)

	A-1	A-2	A-3
Criterion	No Action	LUCs with Beneficial Reuse	Class III Cover with LUCs
Reduction of Mobility, Toxicity, or Volume Through Treatment			
Type of Reduction	No reduction	No reduction	No reduction
Degree of Expected Reduction in Toxicity, Mobility, or Volume	No reduction	No reduction	No reduction
Short-Term Effectiveness and Performance			
Amount of Hazardous Material Destroyed or Treated	No reduction	No reduction	No reduction
Risk to Remedial Worker	No risk	Minimal; Health and Safety Plan will be implemented to protect remedial workers	Minimal; Health and Safety Plan will be implemented to protect remedial workers
Risk to Community	None	None	None
Risk to Environment	None	None	None
Time to Implement and achieve RAO	Never	12+ years	18 months
Implementability			
Availability of Materials, Equipment, Contractors	Not Applicable	Readily Available	Readily Available
Ability to Construct and Operate the Technology	Not Applicable	Proven technology at SRS	Proven technology at SRS
Ability to Obtain Permits/Approvals from Other Agencies	Not Applicable	Prior history with similar permits/approvals at SRS	Prior history with similar permits/approvals at SRS

Table 8 Comparison of Alternatives to CERCLA Criteria for the Remaining Coal Ash and Coal Fines Operable Units (*Continued/End)*

	A-1	A-2	A-3
Criterion	No Action	LUCs with Beneficial Reuse	Class III Cover with LUCs
Estimated Cost*			
Total Capital Cost	$0	$23,089,898	$48,165,265
Present Worth O&M Cost	$0	$16,518,056	$11,499,505
Total Cost	$0	**$39,607,954**	**$59,664,770**

*-for itemized costs per ash OU see Appendix H.

Table 9 Summary of the Comparative Ranking Analysis

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 A-1	No	NA	1	1	1	5	$ 0	8
Alternative A-2 AAP ACPRB FAL HAB KAB LAB **Total**	Yes	Yes	5	1	3	4	$2,477,495 $1,005,629 $13,831,805 $9,033,599 $7,327,969 $5,931,458 **$39,607,954**	13
Alternative A-3 AAP ACPRB FAL HAB KAB LAB **Total**	Yes	Yes	4	1	4	4	N/A $8,155,203 $10,741,846 $13,504,181 $11,185,501 $16,387,052 $**59,664,770**	13

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

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APPENDIX A

INVESTIGATION DATA/DATA SUMMARY TABLE

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APPENDIX A. INVESTIGATION DATA / DATA SUMMARY TABLE

This appendix provides the data used in the human health risk assessment, principal threat source material evaluation, ecological risk assessment, and contaminant migration analysis for the F-Area Ash Landfill (288-F), H-Area Ash Basin (288-H), K-Area Ash Basin (188-K), and L-Area Ash Basin (188-L). Due to the volume of files generated for each analyte, the output from the ProUCL software (v 5.2) for each analyte is summarized in Table A.1 for the 0 to 0.3 m (0 to 1 ft) interval. The investigation data is provided under separate cover on the electronic version of this document.

The A-Area Ash Pile and A-Area Coal Pile Runoff Basin OU was investigated in 2008 and documented in the approved *Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit*. The data associated with the A-Area Ash Pile and A-Area Coal Pile Runoff Basin OU is not included in this appendix.

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Table A.1. Data Summary Table for Surface Soil/Ash (0 to 0.3 m [0 to 1 ft])

ANALYTE NAME	Units	Samples	Non-Detects	Detects	# J Detects	Distr.	UCL Method	Mean	95% UCL	Max	Min	RME	Max Location	Qual. of Max	Max Date
Inorganics															
Aluminum	mg/kg	9	0	9	0	N	2	7082	10716	21600	1950	10716	LASH-001		5/11/2020
Arsenic	mg/kg	9	0	9	0	Na	2	25.19	37.61	76.5	12.1	37.61	HASH-002		5/11/2020
Barium	mg/kg	9	0	9	0	N	2	180.7	259.7	479	79.5	259.7	LASH-001		5/11/2020
Beryllium	mg/kg	9	0	9	0	N	2	2.152	2.923	5.06	0.835	2.923	LASH-001		5/11/2020
Calcium	mg/kg	9	0	9	0	Na	2	10047	19958	45900	624	19958	LASH-001		5/11/2020
Chromium	mg/kg	9	0	9	0	N	2	9.963	12.79	18.7	5.75	12.79	LASH-005		5/11/2020
Cobalt	mg/kg	9	0	9	0	N	2	6.521	7.96	10.1	2.42	7.96	LASH-001		5/11/2020
Copper	mg/kg	9	0	9	0	N	2	29.77	35.1	39	16.9	35.1	HASH-003		5/11/2020
Iron	mg/kg	9	0	9	0	N	2	9918	13031	21600	5310	13031	LASH-001		5/11/2020
Lead	mg/kg	9	0	9	0	N	2	8.312	10.29	12.5	4.17	10.29	LASH-003/005		5/11/2020
Magnesium	mg/kg	9	0	9	0	Na	2	1061	2107	5440	175	2107	LASH-001		5/11/2020
Manganese	mg/kg	9	0	9	0	N	2	65.49	106.7	230	12.9	106.7	LASH-001		5/11/2020
Mercury	mg/kg	9	0	9	2	N	2	0.0564	0.0739	0.103	0.0146	0.0739	KASH-004		5/11/2020
Nickel	mg/kg	9	0	9	0	N	2	12.17	14.28	15.5	4.59	14.28	HASH-001		5/11/2020
Potassium	mg/kg	9	0	9	0	N	2	644.7	994.3	1950	151	994.3	HASH-003		5/11/2020
Selenium	mg/kg	9	0	9	9	N	2	2.212	2.592	3.09	1.32	2.592	LASH-005		5/11/2020
Sodium	mg/kg	9	0	9	2	Na	2	124	236.3	592	27.5	236.3	LASH-001		5/11/2020
Vanadium	mg/kg	9	0	9	0	N	2	25.64	32.95	48.8	13.1	32.95	LASH-001		5/11/2020
Zinc	mg/kg	9	0	9	0	N	2	14.24	17.78	26.7	8.81	17.78	HASH-001		5/11/2020
Organics															
2-Methylnaphthalene	mg/kg	9	1	8	3	NP	1	0.141	0.223	0.415	ND	0.223	KASH-005		5/11/2020
Benzo(g,h,i)perylene	mg/kg	9	8	1	1	---	---	0.0097	---	0.0297	ND	0.0297	KASH-001	J	5/11/2020
Benzo[a]anthracene	mg/kg	9	6	3	3	NP	1	0.0246	0.0219	0.0326	ND	0.0219	KASH-001	J	5/11/2020
Benzo[a]pyrene	mg/kg	9	8	1	1	---	---	0.0081	---	0.0152	ND	0.0152	KASH-001	J	5/11/2020
Benzo[b]fluoranthene	mg/kg	9	6	3	2	NP	1	0.0243	0.0222	0.0375	ND	0.0222	KASH-001		5/11/2020

Table A.1. Data Summary Table for Surface Soil/Ash (0 to 1 ft) *(Continued)*

ANALYTE NAME	Units	Samples	Non-Detects	Detects	# J Detects	Distr.	UCL Method	Mean	95% UCL	Max	Min	RME	Max Location	Qual. of Max	Max Date
Bis(2-ethylhexyl)phthalate	mg/kg	9	7	2	2	NP	1	0.0141	0.0136	0.0165	ND	0.0136	KASH-005	J	5/11/2020
Chrysene	mg/kg	9	5	4	4	NP	1	0.0269	0.0255	0.0351	ND	0.0255	KASH-005	J	5/11/2020
Di-n-butyl phthalate	mg/kg	9	8	1	1	---	---	0.0091	---	0.0246	ND	0.0246	HASH-003		5/11/2020
Fluoranthene	mg/kg	9	6	3	2	NP	1	0.0297	0.0269	0.0497	ND	0.0269	KASH-001		5/11/2020
Indeno[1,2,3-cd]pyrene	mg/kg	9	8	1	1	---	---	0.0079	---	0.013	ND	0.013	HASH-003		5/11/2020
Naphthalene	mg/kg	9	3	6	2	NP	1	0.117	0.146	0.26	ND	0.146	KASH-005		5/11/2020
Phenanthrene	mg/kg	9	2	7	3	NP	1	0.107	0.141	0.228	ND	0.141	KASH-001		5/11/2020
Pyrene	mg/kg	9	5	4	3	NP	1	0.0345	0.0341	0.0642	ND	0.0341	KASH-001		5/11/2020
Radionuclides															
Actimium-228	pCi/g	9	0	9	0	N	2	2.509	2.994	4.15	1.3	2.994	HASH-002		5/11/2020
Bismuth-212	pCi/g	9	0	9	7	N	2	2.873	3.418	4.23	1.45	3.418	HASH-002		5/11/2020
Bismuth-214	pCi/g	9	0	9	0	N	2	2.973	3.792	5.57	0.803	3.792	LASH-001		5/11/2020
Cesium-137	pCi/g	9	7	2	1	NP	1	0.191	0.144	0.226	ND	0.144	LASH-005		5/11/2020
Gross Alpha	pCi/g	9	0	9	9	N	2	36.68	43.33	50.5	19.7	43.33	LASH-001		5/11/2020
Lead-212	pCi/g	9	0	9	0	N	2	2.334	2.777	3.55	1.06	2.777	HASH-002		5/11/2020
Lead-214	pCi/g	9	0	9	0	N	2	3.411	4.377	6.26	1.02	4.377	LASH-001		5/11/2020
Nonvolatile Beta	pCi/g	9	0	9	0	N	2	25.77	31	36.8	9.7	31	LASH-003		5/11/2020
Potassium-40	pCi/g	9	0	9	0	N	2	9.197	11.16	12.5	2.3	11.16	KASH-005		5/11/2020
Radium-226	pCi/g	9	0	9	0	N	2	4.263	5.537	8.63	1.5	5.537	LASH-001		5/11/2020
Radium-228	pCi/g	9	8	1	1	---	---	0.5643	---	1.1	ND	1.1	LASH-003		5/11/2020
Thallium-208	pCi/g	9	0	9	0	N	2	0.682	0.824	1.04	0.27	0.824	HASH-002		5/11/2020
Thorium-228	pCi/g	9	0	9	3	N	2	2.643	3.332	4.27	0.878	3.332	HASH-002		5/11/2020
Thorium-230	pCi/g	9	0	9	0	N	2	4.24	5.526	8.02	2.11	5.526	LASH-001		5/11/2020
Thorium-232	pCi/g	9	0	9	2	N	2	2.537	3.099	3.9	1.2	3.099	KASH-004		5/11/2020
Uranium-233/234	pCi/g	9	0	9	1	N	2	3.393	4.361	6.72	1.64	4.361	LASH-001		5/11/2020

Table A.1. Data Summary Table for Surface Soil/Ash (0 to 1 ft) *(Continued/End)*

ANALYTE NAME	Units	Samples	Non-Detects	Detects	# J Detects	Distr.	UCL Method	Mean	95% UCL	Max	Min	RME	Max Location	Qual. of Max	Max Date
Uranium-235	pCi/g	9	8	1	1	---	---	0.2721	---	0.561	ND	0.561	LASH-001	J	5/11/2020
Uranium-238	pCi/g	9	0	9	1	N	2	3.366	4.306	5.82	1.42	4.306	LASH-001		5/11/2020

a assumed normal distribution; UCL based on 95% Student's-t UCL; mean reported by ProUCL
b presented as a range rather than a distribution (for PH results only)
na = not applicable; ND = Non-Detect; RME = Reasonable Maximum Exposure; UCL = Upper Confidence Limit
Distribution (Distr.): N = Normal; NP = Non-Parametric
UCL Method Code: 1 = 95% KM (t) UCL; 2 = 95% Student's-t UCL
Qual. of Max = Qualifier of Maximum

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APPENDIX B

CONTAMINANT FATE AND TRANSPORT

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximately
θ_e	effective moisture content
θ_{ei}	layer *i* effective moisture content
θ_w	water-filled soil porosity
θ_{wi}	layer *i* water-filled soil porosity
θ_a	air-filled soil porosity
η_e	effective porosity
η_{ei}	layer *i* effective porosity
η_t	total porosity
η_{ti}	layer *i* total porosity
ρ_b	dry soil bulk density
λ	decay rate constant
AAP	A-Area Ash Pile (788-A)
ac	acre
ACPRB	A-Area Coal Pile Runoff Basin (788-3A)
amsl	above mean sea level
bgs	below ground surface
b_i	layer *i* Clapp and Hornberger "*b*" parameter based on soil texture
BRA	baseline risk assessment
C_{gw}	groundwater concentration
CM	contaminant migration
CMS	Corrective Measures Study
COC	constituent of concern
COPC	constituent of potential concern
C_{sat}	saturation concentration
C_t	input contaminant soil concentration
d	mixing zone depth (minimum of d_i and d_a)
d_a	measured saturated zone thickness
DAF	dilution attenuation factor
d_i	calculated mixing zone depth
d_s	average source thickness
ED	exposure duration
f_{oc}	soil organic carbon content as mass fraction
FAL	F-Area Ash Landfill (288-F)
ft	feet, foot

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

FS	Feasibility Study
H', *H*	Henry's Law Constant
ha	hectare
HAB	H-Area Ash Basin (288-H)
i	saturated zone hydraulic gradient
I	infiltration rate through vadose zone
IWT	Industrial Wastewater Treatment
K_a	saturated zone hydraulic conductivity
K_d	soil-water partitioning coefficient
KAB	K-Area Ash Basin (188-K)
kg	kilogram
K_{oc}	organic carbon partitioning coefficient
K_{si}	layer *i* Clapp and Hornberger "*K*" parameter based on soil texture
L	length of the source parallel to groundwater flow
LAB	L-Area Ash Basin (188-L)
L	liter
L_v	length from the bottom of the source zone to the top of the water table
m	meter
m^3	cubic meter
MCL	maximum contaminant level
mg	milligram
MLSSL	mass-limited soil screening level
NA	not available; not applicable
NAPL	non-aqueous phase liquid
ND	no detections
OU	operable unit
pCi/g	picocurie per gram
R	retardation coefficient
PRG	preliminary remedial goal
RCOC	refined constituent of concern
RFI	Resource Conservation and Recovery Act Facility Investigation
RI	Remedial Investigation
RSL	regional screening level
S	solubility constant in water

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED/END)

SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SSL	soil screening limit
t	time of exposure
$T_{1/2}$, $t_{1/2}$	half-life
T_c	total depth of soil column
T_e	evaluation time
T_{hi}	layer *i* vertical thickness
T_{Mean}, T_t	mean travel time
T_{ti}	layer *i* mean travel time
UCL	upper confidence limit
µg/L	microgram per liter
USEPA	U.S. Environmental Protection Agency
UTRA	Upper Three Runs Aquifer
V_s	vadose zone mean pore water velocity
V_{si}	layer *i* mean pore water velocity
VZCOMML©	Vadose Zone Contaminant Migration Multi-Layered Model, Version 4.0
WSRC	Westinghouse Savannah River Company
WSRC	Washington Savannah River Company; After September 2006
yd^3	cubic yard
yr	year

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B-1. CONTAMINANT FATE AND TRANSPORT

The purpose of this appendix is to provide a discussion of the contaminant fate and transport analyses for the remaining coal ash and coal fines operable units (OUs) at the Savannah River Site (SRS), which include the A-Area Ash Pile (788-A) (AAP), A-Area Coal Pile Runoff Basin (788-3A) (ACPRB), F-Area Ash Landfill (288-F) (FAL), H-Area Ash Basin (288-H) (HAB), K-Area Ash Basin (188-K) (KAB), and L-Area Ash Basin (188-L) (LAB) OUs. Contaminant migration (CM) analyses for the AAP and ACPRB OUs were completed in 2012 and reported in the approved *RFI/RI Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit (U)* (SRNS 2012). The CM analyses of the AAP and ACPRB OUs are complete and identified no CM refined constituents of concern (RCOCs).

Ash samples were collected from the HAB, KAB, and LAB OUs in May 2020, and the data were combined into one dataset and processed in accordance with the approved protocols in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2023a). Representatives from the U.S. Department of Energy, U.S. Environmental Protection Agency (USEPA), and South Carolina Department of Environmental Services[1], who are the remedial decision makers for the project (the Core Team), agreed at the November 2023 Focused Corrective Measures Study/Feasibility Study Scoping Meeting that ash within the three sampled basin OUs is consistent, and the compiled dataset could be used for baseline risk assessment, CM analysis, and remedial decision making for the HAB, KAB, and LAB OUs (SRNS 2023b). In addition, review of metals data collected in 2012 for waste characterization of the FAL confirmed ash concentrations are similar to ash data collected from the HAB, KAB, and LAB OUs. The Core Team agreed that the results from the HAB, KAB, and LAB OUs would also apply to the FAL OU (SRNS 2023b).

[1] SCDES was known as the South Carolina Department of Health and Environmental Control prior to July 1, 2024.

The CM analyses were performed using the spreadsheet model, VZCOMML© (V.4.0)[2], which accounts for decay processes, infiltration rate, soil properties, vadose zone thickness, and chemical behavior. Soil screening limits (SSLs) were calculated by the model. An exceedance of a SSL by a vadose zone constituent indicates that the resultant maximum groundwater concentration has the potential to exceed the regulatory limits (e.g., maximum contaminant levels [MCLs]) within the compliance period of 1,000 years (yr). Interpretation of the results and discussion of exceeding constituents are provided in the following sections of this appendix.

B-2. CONTAMINANT MIGRATION MODEL

B-2.1. Background

F-Area Ash Landfill (288-F) Operable Unit

The FAL OU is an active Class II Landfill (South Carolina Department of Health and Environmental Control[3] Solid Waste Landfill Permit #025800-1601). The FAL OU consists of the active FAL (288-F) and the area outside the 288-F boundary where ash deposits are known to exist (Figure B-1). The FAL OU became operational in 1954 and received ash from the A-, F-, and H-Area powerhouses during its operational history. The FAL OU is located in the Upper Three Runs watershed between F and H Areas.

The interior area of the FAL OU is approximately (~) 2.84 hectares (ha) (7.01 acres [ac]) and there is an estimated 4.64 ha (11.47 ac) of ash observed outside of the FAL OU boundary (Figure B-1). In 2012, the volume of ash within the FAL OU was estimated to be 151,458 cubic meters (m^3) (198,099 cubic yards [yd^3]). The volume of ash observed outside of the FAL OU boundary was estimated to be an additional 11,744 m^3 (15,360 yd^3), for a total volume of 163,201 m^3 (213,459 yd^3) (SRNS 2020). The FAL OU is surrounded by a relatively congested industrial area and has engineered storm water controls in place. The water table elevation in the area is estimated at 70.1 meters (m) (230 feet [ft]) above mean sea level (amsl). The bottom of the ash is at 89.3 m

[2] Vadose Zone Contaminant Migration Multi-Layered Model (VZCOMML©) Version 4.0, Copyright TXu 1-663-361, 2009, Savannah River Nuclear Services, LLC.
[3] South Carolina Department of Health and Environmental Control is now know as SCDES, as of July 1, 2024. However, at the time of this document, the landfill permit for the FAL OU had not been updated to the new name.

(293 ft) amsl. The thickness of ash is up to 5.2 m (17 ft) in some areas of the FAL OU. Vadose zone soil lithology was taken from nearby well core descriptions (monitoring well FAC-1P and NWP-1B; Attachment B-1 and Attachment B-2, respectively), with layers of loamy sand, sandy clay, and sandy loam soil classifications. The water table in this area is in the Upper Three Runs Aquifer (UTRA), which consists of sandy loam soils.

H-Area Ash Basin (288-H) Operable Unit

The HAB OU is located in the Fourmile Branch watershed, downgradient of H Area and is an active basin (Figure B-2). A known/suspected Carolina Bay is partially located within the southeastern boundary of the HAB OU. The HAB OU receives rainwater runoff discharge from an above ground pipeline located behind the H-Area Powerhouse (284-H) and has an active Industrial Wastewater Treatment (IWT) permit. All operating systems in the H-Area Powerhouse have been shut down, however during operation, the HAB OU received ash via sluice of wet ash slurry from the H-Area Powerhouse. The H-Area Powerhouse operated from 1950 to 1990. In 1993 to 1994, ~76,455 m^3 (100,000 yd^3) of ash was removed from the basin and transported to the FAL OU and F-Area Ash Basin (288-1F).

The area of the HAB OU is 5.29 ha (13.06 ac), with an estimated 7.45 ha (18.40 ac) of ash observed outside of the HAB OU boundary (Figure B-2). The estimated volume of ash is 198,105 m^3 (259,112 yd^3) inside and outside of the basin boundary (SRNS 2020). The basin is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. Standing water is frequently encountered in the southeast side of the basin. The water table of the shallowest groundwater in this area is estimated at 83 m (273 ft) amsl. The bottom of the ash was estimated to be at 85 m (279 ft) amsl (SRNS 2020). In some locations within the HAB OU, ash is as thick as 2.8 m (9 ft). The vadose zone soils between the ash and the water table consist of sandy clay texture classification, based on the boring description from monitoring well HPM-19 (Attachment B-3). The water table aquifer is the UTRA and consists of a sandy clay loam matrix in this area.

K-Area Ash Basin (188-K) Operable Unit

The KAB OU is located southwest of the K-Reactor complex and is in the Pen Branch watershed. The KAB OU received ash from the coal-fired K-Area Powerhouse (184-K) via wet sluice. The powerhouse operated from 1951 to 1990. The KAB OU has an active IWT permit and receives stormwater from the K-Area Ameresco Biomass Facility in the form of process blowdown water during the winter months. As part of the alternative evaluation for the remaining coal ash and coal ash fines OUs strategy development, three ash/soil samples were collected from the KAB OU in 2020 to compare with results to similar OUs and to obtain geophysical data. In addition, the extent of ash distribution was evaluated by field observations from multiple transects located outside the KAB OU boundary (SRNS 2020).

The KAB OU covers an area of ~4.52 ha (11.16 ac) within the unit boundaries, and an additional 1.54 ha (3.81 ac) estimated outside of the boundary by field observations (Figure B-3). The total volume of ash at the KAB OU is estimated as 208,362 m^3 (272,527 yd^3), inside and outside of the unit boundary (SRNS 2020). The majority of the basin is covered in vegetation. Ash thickness is unevenly distributed throughout the basin, with the depth ranging up to 4.9 m (16 ft) in some areas. The bottom of the ash at the KAB OU is at 73.8 m (242 ft) amsl (SRNS 2020). The water table at the KAB OU is at ~62.5 m (205 ft) amsl. Vadose zone soils between the water table and bottom of ash consist of sand and clay matrix with classifications of sandy clay loam and sandy loam. The UTRA is the water table aquifer and consists of sandy loam soil. Soil classifications were determined using nearby monitoring well PW-34K soil descriptions (Attachment B-4).

L-Area Ash Basin (188-L) Operable Unit

The LAB OU is an inactive ash basin and is located northeast of the L-Reactor Complex. It is primarily located within the Pen Branch watershed (Figure B-4). A small southeastern portion of the basin is located in the Steel Creek watershed. The LAB OU received ash from the coal-fired L-Area Powerhouse (184-L) via wet sluice. The powerhouse operated from 1951 to 1968. Currently, the LAB is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. The northern portion of the basin is frequently inundated with water.

The interior area of the basin is ~7.13 ha (17.61 ac), with ash present over about 0.68 ha (1.67 ac) exterior to the basin, as confirmed by field observations (Figure B-4). The total volume of ash is estimated to be 246,971 m^3 (323,026 yd^3), including ash inside and outside of the unit boundary. Depth of ash was up to 4.3 m (14 ft) at some locations, with an ash bottom at 74 m (243 ft) amsl. The shallowest water table is the UTRA, which is at 71 m (233 ft) amsl in this area. The vadose zone soils between the ash and water table are sandy with intermixed silts and clays. The shallow water table is the UTRA, consisting of sandy loam soils in the area. Soil descriptions were determined based on nearby monitoring well LSW-5C lithologic descriptions (Attachment B-5).

B-2.2. Screening Methods

This section describes screening methods used for identifying CM constituents of potential concern (COPCs) and CM constituents of concern (COCs). The identification of CM COPCs and CM COCs was facilitated by the program VZCOMML© V.4.0.

This CM analyses followed the protocols and guidelines established in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2023a). For the Tier I screen, each OU was modeled under the most conservative assumptions for source thickness, depth to groundwater, and subsurface properties. USEPA default SSLs were calculated for the Tier I screen, which were then compared to the maximum concentrations of all detected constituents. Constituents with concentrations that were greater than the calculated Tier I SSLs have the potential to impact groundwater at levels exceeding action levels and therefore were retained as Tier I CM COPCs. A less conservative set of assumptions was used for the Tier II analyses to assess impact to groundwater at concentrations exceeding action levels within the evaluation time (T_e) of 1,000 yrs. The Tier II screen accounts for physical and chemical complexities associated with vadose zone transport and more accurately predict risks of exposure via the CM pathway. Constituents with maximum source zone concentrations that exceed the Tier II SSLs within the T_e , were retained as Tier II CM COCs.

Both the Tier I and Tier II screens include infinite source mass and limited source mass calculations. In reality, the consideration of an infinite source mass is not reasonable, so the mass-limited calculations (default mass-limited SSLs and SRS site-specific mass-limited SSLs

[MLSSL]) consider the entire release of the source mass within a 70-yr exposure period. This prevents a source mass balance error (i.e., releasing more contaminant mass than is actually contained in the source) in the calculation, which is likely with the infinite source scenario. Equations used to calculate Tier I and Tier II SSLs and MLSSLs are provided in Section B-2.3.

The spreadsheet model VZCOMML© was developed at SRS to facilitate SSL calculations and Tier I/Tier II soil data CM screening. VZCOMML© simultaneously calculates SSLs for Target Analyte List and Target Compound List constituents and for specified radionuclides (a total of 219 constituents). VZCOMML© compares user-entered soil concentrations (maximum values) to calculated SSLs and identifies constituents that are Tier I CM COPCs and Tier II CM COCs. Chemical properties of analytes used by VZCOMML© (e.g., soil/water distribution coefficient [K_d], Henry's Law constant [H', H], etc.) are listed in Table B-1. VZCOMML© also contains assigned hydraulic functions for different types of soil layers (e.g., source layer, soil layer, or engineered barrier layer) and texture classifications (e.g., sand, loamy sand, clay, concrete) within the soil column. The Tier II screen completed by VZCOMML© also uses soil concentrations input by the user to calculate maximum groundwater concentrations and migration times.

If Tier II CM COCs are identified, it is up to the user to evaluate results and apply professional judgment, other modeling approaches, and/or knowledge of site conditions and geochemistry to further refine the list of CM COCs in an uncertainty discussion. Constituents that are retained following the uncertainty discussion are identified as CM RCOCs, which are constituents that are mobile at that waste unit, can leach to the aquifer within a 1,000-yr travel time (per the approved protocols), and are predicted to exceed drinking water standards at a receptor well located adjacent to the edge of the OU.

B-2.3. Soil Screening Equations

Equations used by VZCOMML© are consistent with USEPA Soil Screening Guidance (USEPA 1996, 2000). A conceptual framework of the model and vadose zone and screening parameters for VZCOMML© is provided in Figure B-5. Model assumptions include:

1. A receptor drinking water well at the downgradient edge of the source zone with the well screen located in the plume.

2. Linear equilibrium isotherms are used rather than exponential isotherms (this is typically a conservative estimate [i.e., likely transports more contaminant to water table] of partitioning into the aqueous phase of a moving front).

3. Uniformly distributed contamination in the subsurface (this is also typically a conservative estimate using the maximum concentration across the entire unit for each constituent).

4. Instantaneous equilibrium partitioning within soil, vapor, and liquid phases (this is typically a conservative estimate [i.e., likely transports more contaminant to water table] of partitioning into the aqueous phase of a moving front for compounds that have lower Henry's Law constants).

In the VZCOMML© model construction, the source zone layer thickness represents the vertical extent of contamination. Generally, Layer 1 is the source zone and Layers 2 through 5 (if applicable) are the vadose zone layers beneath the source zone and were used to simulate soil heterogeneity in the soil column. These layers can accommodate different hydraulic functions, soil textures, properties, and layer thicknesses for up to five total soil layers (including source layer). The aquifer layer represents the shallowest water table aquifer. Following is a discussion of the equations used by VZCOMML© for the soil screening process.

B-2.3.1. Dilution Attenuation Factor

The dilution attenuation factor (DAF) represents leachate dilution in the water table aquifer. The DAF calculation assumes that the aquifer is unconfined, unconsolidated, isotropic, and homogeneous. The minimum DAF is one, which indicates no dilution occurs in the aquifer. The USEPA recommends a default DAF of 20 for sites up to 0.2 ha (0.5 ac) whenever site-specific data are not available (USEPA 1996). The DAF (dimensionless) is calculated as follows:

$$\mathrm{DAF} = 1 + \frac{K_a \cdot i \cdot d}{I \cdot L}$$

where;

K_a = saturated zone (aquifer) hydraulic conductivity (ft/yr)

i = saturated zone (aquifer) hydraulic gradient (ft/ft)

I = infiltration rate through vadose zone (ft/yr)

L = length of the source (parallel to groundwater flow) (ft)

d_a = measured saturated zone (aquifer) thickness (ft)

d_i = calculated mixing zone depth (ft)

d = mixing zone depth (minimum of d_i and d_a) (ft)

If the input infiltration rate through the vadose zone is greater than any of the individual vadose zone layer saturated hydraulic conductivities, then the infiltration rate is adjusted to the maximum of the individual vadose zone layer saturated hydraulic conductivities. The calculated mixing zone depth (d_i) is defined as follows:

$$d_i = \sqrt{0.0112 \cdot L^2} + d_a\left(1 - e^{\left(-L \cdot I/(K_a \cdot i \cdot d_a)\right)}\right)$$

The actual mixing zone depth (d) value cannot exceed the actual aquifer thickness (d_a). Therefore, the mixing zone depth is the minimum of d_i or d_a. This can tend to underpredict localized contaminant concentrations in groundwater by immediately diluting the concentrations over the full aquifer extent when the contaminant reaches groundwater but is adjustable to accommodate mixing or lack thereof.

B-2.3.2. Soil Partitioning

The SSL soil concentration is back-calculated by two methods: 1) SSL (infinite source) and 2) MLSSL (finite source). The Tier I SSL assumes an infinite source and uses a linear equilibrium soil-water partitioning isotherm. The Tier I SSL (*TierI_SSL*, milligram per kilogram [mg/kg]) is calculated for organic contaminants and mercury (with vapor phase) as follows:

$$TierI_SSL = \frac{MCL}{1000} \cdot DAF \cdot \left[K_d + \frac{(\theta_w + \theta_a \cdot H)}{\rho_b}\right]$$

where;

MCL = water-phase concentration limit standard (i.e., MCL or regional screening level [RSL]) (micrograms per liter [µg/L])

K_d = soil-water partitioning coefficient (L/kg)

θ_w = water-filled soil porosity (unitless)

n_t = total porosity (unitless)

θ_a = air-filled soil porosity (unitless), $\theta_a = n_t - \theta_w$

H = Henry's Law constant (dimensionless)

ρ_b = dry soil bulk density (kg/L)

The Tier I SSL (*TierI_SSL*, mg/kg) equation for inorganic contaminants (without vapor phase) is:

$$TierI_SSL = \frac{MCL}{1000} \times DAF \times \left(K_d + \frac{\theta_w}{\rho_b}\right)$$

The Tier I SSL (*TierI_SSL*, picocurie per gram [pCi/g]) for radionuclides is:

$$TierI_SSL = DefaultSSL \times \left(\frac{\lambda t}{1 - e^{(-\lambda t)}}\right)$$

where;

t = time of exposure (USEPA default value of 30 yrs)

λ = decay rate constant ($\frac{\ln(2)}{t_{1/2}}$ [yrs^{-1}])

$t_{½}$ = half-life (yrs)

For organic constituents, the soil-water partitioning coefficient (K_d) (L/kg) is defined by:

$$K_d = f_{OC} \cdot K_{OC}$$

where;

f_{oc} = soil organic carbon content as mass fraction (unitless)

K_{oc} = organic carbon partitioning coefficient (L/kg)

For metals or radionuclides, the K_d is taken from literature and is dependent on the chemical form that exists and the geochemical environment at each site. Normally, the K_d is derived from laboratory column studies. K_d values for metals were determined from the 2021 *Geochemical*

Data Package for Performance Assessment Calculations Related to the Savannah River Site (Kaplan 2021), using the most appropriate values for the specific vadose zone soil type. The water-filled soil porosity (θ_w) is based on a weighted average for all vadose zone layers and calculated as follows:

$$\theta_w = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \theta_{wi}$$

where;

T_{hi} = layer *i* vertical thickness (ft)

T_c = total depth of soil column (ft), $T_c = (d_s + L_v)$

d_s = average source thickness (ft)

L_v = length from the bottom of the source zone to the top of the water table (ft)

θ_{wi} = layer *i* water-filled soil porosity (unitless)

The soil texture is determined for the different layers or soil types observed in the vadose zone, and the soil layer parameters are used to calculate the volumetric water content as follows:

$$\theta_{wi} = n_{ti} \left(\frac{I}{K_{si}}\right)^{\left[\frac{1}{(2b_i+3)}\right]}$$

where;

n_{ti} = layer *i* total porosity (unitless)

K_{si} = layer *i* Clapp and Hornberger "*K*" parameter based on soil texture (ft/yr)

b_i = layer *i* Clapp and Hornberger "*b*" parameter based on soil texture (dimensionless)

The vadose zone total porosity (n_t, unitless) and vadose zone effective porosity (n_e, unitless) are both based on a weighted average for all vadose zone layers and calculated as follows:

$$n_t = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \times n_{ti}$$

$$n_e = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \times n_{ei}$$

where;

n_{ei} = layer *i* effective porosity (unitless)

The effective moisture content θ_e (fraction) is a weighted average for all vadose zone layers as follows:

$$\theta_e = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \times \theta_{ei}$$

where;

θ_{ei} = layer *i* effective moisture content (unitless)

To solve the mass-balance violations inherent in the infinite source equation, USEPA developed the MLSSL (*TierI_MLSSL*, mg/kg) for organics and metals as follows:

$$TierI_MLSSL = \frac{MCL}{1000} \cdot DAF \cdot \frac{I \times ED}{(\rho_b \times d_s)}$$

where;

ED = exposure duration (yr [USEPA default value of 70 yrs])

The MLSSL (*TierI_MLSSL,* pCi/g) equation for radionuclides is:

$$TierI_MLSSL = DefaultMLSSL \cdot \left(\frac{\lambda t}{1 - e^{(-\lambda t)}}\right)$$

B-2.3.3. Mean Travel Time

The mean travel time (T_{Mean} or T_t, yrs) through the vadose zone layers below the source is calculated in VZCOMML© as follows:

$$T_{Mean} = \frac{L_v \cdot R}{V_s}$$

The retardation coefficient (R, dimensionless) is calculated as:

$$R = 1 + \frac{\left(K_d \cdot \rho_\beta\right)}{\theta_e}$$

The mean pore water velocity in the vadose zone (V_s, ft/yr) is a weighted average calculated by:

$$V_s = \sum_{i=1}^{n} \left(\frac{T_{ti}}{T_t}\right) \cdot V_{si}$$

where;

V_{si} = layer i mean pore water velocity (ft/yr)

T_{ti} = layer i mean travel time (yr)

T_t = travel time (yr)

By applying Darcy's Law in the unsaturated zone and assuming steady-state conditions;

$$V_{si} = \frac{\mathrm{I}}{\theta_{wi}}$$

Darcy's Law is not applicable to unstable vadose zone flow, which typically exhibits fingering and other nonlinear behavior, however over most areas this method will typically be a conservative one (i.e., likely transports more contaminant on average to the water table) assuming appropriate hydraulic conductivity values are selected. One pitfall is that preferential pathways are not uncommon and can rapidly transport water (and contaminant) faster than Darcy derived flow in small, localized areas.

B-2.3.4. Incorporating Decay

To account for radioactive decay, chemical degradation, hydrolysis, or biodegradation of constituents and for redistribution of mass in the vadose zone, the Tier I SSLs and Tier I MLSSLs are adjusted using first-order equations in the Tier II $SSL_{T1/2}$ ($TierII_SSL_{T1/2}$) and Tier II $MLSSL_{T1/2}$ ($TierII_MLSSL_{T1/2}$) as follows:

$$TierII_SSL_{T1/2} = \left(\frac{TierI_SSL}{e^{(-\lambda T_{Mean})}}\right) \cdot \left(\frac{T_c}{d_s}\right)$$

$$TierII_MLSSL_{T1/2} = \frac{TierI_MLSSL}{e^{(-\lambda ED)}}$$

where;

T_{Mean} = the mean travel time (yr)

A half-life ($T_{1/2}$, $t_{1/2}$) for a chemical compound is largely determined from literature sources. Because there is usually variability of the reported half-life of a chemical compound (e.g., aerobic and anaerobic rates), the most conservative (longest) half-life is selected as the rate constant in the equations. The rate constants used in the VZCOMML© model are derived from the *Handbook of Environmental Degradation Rates* by P. H. Howard, et al. (Howard 1991).

VZCOMML© assumes equilibration, mass redistribution, and conservation of mass in the source zone between phases (i.e., volatilized, dissolved, or sorbed) and throughout the entire vadose zone volume. This results in more realistic SSLs, which accounts for vadose zone thickness, travel time, and chemical behavior in the subsurface.

The VZCOMML© Tier II screening decision logic for a constituent 'fails' if: 1) the mean travel time (T_{Mean}) through the vadose zone is less than 1,000 yrs, 2) the source concentration exceeds the Tier II $MLSSL_{T1/2}$, and 3) the groundwater concentration exceeds an action level (i.e., the calculated concentration in groundwater would exceed the regulatory limit; MCLs or RSLs). In this case, the constituent would be retained as a CM COC and subject to further CM COC refinement steps.

B-2.3.5. Saturation Concentration

For organic (non-radioactive) constituents, the saturation concentration (C_{sat}) (mg/kg) is calculated from the solubility constant in water (S) (mg/L) as follows:

$$C_{sat=}\frac{S}{\rho_b}\cdot(K_d+\rho_b+\theta_w+H\cdot\theta_a)$$

The C_{sat} is a theoretical concentration that represents a pure non-aqueous phase liquid (NAPL) or solid threshold concentration in soil. The C_{sat} is compared to the detected concentration to predict if a NAPL phase compound is present in the soil.

B-2.3.6. Groundwater Concentration

The concentration of constituents in groundwater in the water table aquifer is directly calculated by VZCOMML© for comparison to groundwater regulatory limits. The groundwater concentration (C_{gw} [µg/L]) is calculated as follows (Rucker 2011):

For organic contaminants (including mercury with vapor phase);

$$C_{gw}=\frac{\left(\frac{C_t\cdot 1000}{DAF}\right)\times e^{(-\lambda T_{mean})}}{\left(K_d+\frac{(\theta_w+H\cdot\theta_a)}{\rho_b}\right)\times\left(\frac{\lambda t}{1-e^{(-\lambda t)}}\right)}\cdot\left(\frac{d_s}{T_c}\right)$$

where;

C_t = input contaminant soil concentration (mg/kg)

For inorganic contaminants (including metals [note: metals use an infinite half-life] and radionuclides and excluding mercury with vapor phase):

$$C_{gw}=\frac{\left(\frac{C_t\cdot 1000}{DAF}\right)\cdot e^{(-\lambda T_{mean})}}{\left(K_d+\frac{\theta_w}{\rho_b}\right)\cdot\left(\frac{\lambda t}{1-e^{(-\lambda t)}}\right)}\cdot\left(\frac{d_s}{T_c}\right)$$

VZCOMML© assumes equilibration, redistribution, and conservation of mass of the source between phases (i.e., volatilized, dissolved, or sorbed) and distribution throughout the entire

vadose zone volume. The concentration of constituents in groundwater in the water table aquifer is directly calculated by VZCOMML© for comparison to groundwater regulatory limits or standards.

B-2.4. Modeling Parameters for the FAL, HAB, KAB, and LAB OUs

Vadose zone CM simulations are presented in this section, using the VZCOMML© spreadsheet, for the remaining coal ash and coal fines OUs. The vadose zone soil layers for the four OUs were modeled based on the best available data from previous soil boring activities. The layers differed for each subunit and were modeled as shown in Table B-2.

These steps were used to perform the CM analysis, for each subunit:

1. Analytical soil data were compiled and evaluated. The data were processed to purge all quality assurance data and rejected (R qualified) data. The data were further processed to select the maximum detected concentration and the 95% upper confidence limit (UCL) for each analyte. The 95% UCL was determined by ProUCL (USEPA 2022).

2. A conceptual site model was developed for each OU, which includes depth of contamination (source zone; Layer 1), vadose zone thickness below the source (Soil Layers 2-5; as appropriate) and assigned values for several hydrogeological parameters.

3. VZCOMML© Tier I screening was performed, using two conservative assumptions: a) for each analyte, the maximum detected soil concentration was used to represent the soil concentration (C_t), and b) the thickness of the source zone was assumed to be equal to the maximum thickness of ash for each OU. An analyte was retained as a Tier I CM COPC if the source zone concentration was greater than both the Tier I Source-Specific SSL and the Tier I MLSSL.

4. VZCOMML© Tier II Simulation 1 was run, using two conservative assumptions: (a) for each analyte, the maximum detected soil concentration was used to represent the soil concentration (C_t), and (b) the thickness of the source zone was assumed to be equal to the maximum thickness of ash for each OU. Analytes predicted to impact groundwater at concentrations exceeding action levels within the evaluation time (T_e) of 1,000 yrs, under the conservative

conditions simulated, were retained as Tier II CM COPCs. Action levels refer to the Tier II $SSL_{T1/2}$, the Tier II $MLSSL_{T1/2}$, and either the May 2024 USEPA MCL or RSL.

5. VZCOMML© model was refined for a Tier II Simulation 2 of the Tier II CM COPCs identified in Step 4 to reduce the high level of conservatism, where justified by site specific data (e.g., using the average or 95% UCL concentration when the maximum value is not representative of a large OU as a whole. The Tier II Simulation 2 represents more realistic conditions than the maximally conservative conditions in Step 4. Analytes predicted to adversely impact groundwater in Simulation 2 were retained as CM COCs.

6. CM COCs were evaluated further using additional lines of inquiry in an uncertainty discussion. After evaluation, retained analytes are identified as CM RCOCs.

7. Screening-level CM preliminary remedial goals (PRGs) were calculated for each CM RCOC (generally, the CM PRG is the highest Tier II SSL concentration).

Table B-1 presents chemical and physical property parameters for each evaluated analyte. These parameters include organic carbon partitioning coefficient (K_{oc}), soil-water partitioning coefficient (K_d), half-life (biological degradation for organics; radioactive decay for radionuclides [$T_{1/2}$, $t_{1/2}$]), Henry's Law constant (H', H), solubility (S), and regulatory action level (USEPA MCL or RSL). In addition to chemical parameters, several physical parameters were also employed in CM simulations. Since the geologic environment of all evaluated OUs are similar, many of the same physical parameters were used for all subunits, presented in Table B-3. In addition to general parameters listed in Table B-3, physical parameters, which are specific to certain OUs and refined simulations, are presented in Table B-4.

B-2.5. Results of the Tier I and Tier II Analyses

In this section, results of the Tier I and Tier II screening are presented for each of the four OUs. Certain constituents did not undergo SSL calculations. These constituents included compounds which lack both MCLs and RSLs (e.g., phenanthrene), constituents that are essential nutrients (e.g., calcium and radiological progeny of radium-226 and radium-228 [the radium-226/228 MCL takes risk due to progeny into account]). These analytes did not undergo CM COC evaluation and

were listed as "NA," or not applicable, in Tables B-5 through B-12. However, mean travel times (T_{Mean}, T_t) and groundwater concentrations (C_{gw}) were predicted for the compounds which lack MCLs/RSLs.

B-2.5.1. FAL OU Results

The FAL OU is an active Class II Landfill that received ash from the A-, F-, and H-Area powerhouses. The area of ash at the FAL OU is ~7.48 ha (18.48 ac) and has a source length 396 m (1,300 ft) parallel to the groundwater flow direction.

B-2.5.1.1. FAL OU Tier I Analysis

The Tier I screen was performed with a 5.2 m (17 ft) sand source layer (Layer 1), which is a conservative soil classification and is consistent with previous CM analyses of ash units. Layer 2 consisted of a 3.4 m (11 ft) loamy sand layer, followed by a 6.7 m (22 ft) sandy clay layer (Layer 3), and finally a 9.1 m (30 ft) sandy loam layer (Layer 4). Soil layer descriptions are based on the field geologic log for the nearest soil borings, FAC-1P and NWP-1B (Attachment B-1 and Attachment B-2, respectively). The water table was modeled at 24 m (80 ft) below ground surface (bgs). The Tier I screen identified 17 constituents as CM COPCs: benzo(a)anthracene, naphthalene, aluminum, arsenic, barium, beryllium, cobalt, iron, manganese, nickel, potassium-40, radium-226, thorium-230, thorium-232, uranium-233/234, uranium-235, and uranium-238 (Table B-5).

B-2.5.1.2. FAL OU Tier II Analysis

The 17 constituents which failed the Tier I screen were evaluated in a Tier II screen. The Tier II screen did not identify any Tier II CM COPCs (Table B-6).

B-2.5.2. HAB OU Results

The HAB OU is an active ash basin located in the Fourmile Branch watershed, downgradient of H Area. The area of ash at the HAB OU is ~12.73 ha (31.46 ac) and has a source length 472 m (1,550 ft) parallel to the groundwater flow direction.

B-2.5.2.1. HAB OU Tier I Analysis

The Tier I screen was performed with a 2.7 m (9 ft) source layer (Layer 1), corresponding to the deepest depth of ash at the OU. Layer 2 consisted of a 1.8 m (6 ft) thick sandy clay layer. The water table was modeled at 4.6 m (15 ft) bgs. The Tier I screen identified 17 constituents as CM COPCs: benzo(a)anthracene, naphthalene, aluminum, arsenic, barium, beryllium, cobalt, iron, manganese, nickel, potassium-40, radium-226, thorium-230, thorium-232, uranium-233/234, uranium-235, and uranium-238 (Table B-7).

B-2.5.2.2. HAB OU Tier II Analysis

The 17 constituents which failed the Tier I screen were evaluated in a Tier II screen. Five constituents were further identified as Tier II CM COCs: barium, nickel, uranium-233/234, uranium-235, and uranium-238 (Table B-8).

B-2.5.3. KAB OU Results

The KAB OU received ash from the K-Area Coal-Fired Powerhouse via wet sluice and has an active IWT permit, receiving stormwater from the K-Area Ameresco Biomass Facility. The area of ash at the KAB OU is ~6.06 ha (14.97 ac) and has a source length 223 m (730 ft) parallel to the groundwater flow direction.

B-2.5.3.1. KAB OU Tier I Analysis

The Tier I screen was performed with a 4.9 m (16 ft) source layer (Layer 1), corresponding to the depth of ash at the OU. Below the source layer is a 6.1 m (20 ft) thick soil layer with texture classification of sandy clay loam (Layer 2). The next soil layer is a 3.0 m (10 ft) thick soil layer with texture classification of sandy loam (Layer 3). The final soil layer above the water table is a 2.1 m (7.0 ft) thick sandy clay loam layer (Layer 4). The water table was modeled at 16.2 m (53 ft) bgs. The Tier I screen identified 16 constituents as CM COPCs: benzo(a)anthracene, naphthalene, arsenic, barium, beryllium, cobalt, iron, manganese, nickel, potassium-40, radium-226, thorium-230, thorium-232, uranium-233/234, uranium-235, and uranium-238 (Table B-9).

B-2.5.3.2. KAB OU Tier II Analysis

The 16 constituents which failed Tier I screen were evaluated in a Tier II screen. The Tier II screen did not identify any Tier II CM COPCs (Table B-10).

B-2.5.4. LAB OU Results

The LAB OU is an inactive ash basin located northeast of the L-Reactor Complex and is in the Pen Branch watershed. The area of ash at the LAB OU is ~7.80 ha (19.28 ac) and has a source length 335 m (1,100 ft) parallel to the groundwater flow direction.

B-2.5.4.1. LAB OU Tier I Analysis

The Tier I screen was performed with a 4.3 m (14 ft) source layer (Layer 1), corresponding to the depth of ash at the OU. Layer 2 consisted of a 2.1 m (7.0 ft) thick sandy loam layer. The final layer was a 0.9 m (3.0 ft) thick sandy clay loam layer (Layer 3). The water table was modeled at 7.3 m (24 ft) bgs. The Tier I screen identified 16 constituents as CM COPCs: benzo(a)anthracene, naphthalene, arsenic, barium, beryllium, cobalt, iron, manganese, nickel, potassium-40, radium-226, thorium-230, thorium-232, uranium-233/234, uranium-235, and uranium-238 (Table B-11).

B-2.5.4.2. LAB OU Tier II Analysis

The 17 constituents which failed the Tier I screen were evaluated in a Tier II screen. Two constituents were further identified as Tier II CM COCs: barium and nickel (Table B-12).

B-2.6. Uncertainty Discussion

The CM soil screening analyses for HAB OU, KAB OU, LAB OU, and FAL OUs identified CM COCs for two of the OUs. For the HAB OU, barium, nickel, uranium-233/234, uranium-235, and uranium-238 were retained following the Tier II screening step. For the LAB OU, barium and nickel were retained following the Tier II screening step. These constituents were evaluated further using additional lines of evidence to determine if they should be retained as final CM RCOCs.

B-2.6.1. HAB OU Uncertainty Analysis

Barium – Barium was detected in all nine samples with an average result of 180.7 mg/kg and a maximum concentration of 479 mg/kg (Table B-13). The maximum SRS background barium concentration is 252 mg/kg (WSRC 2006). The average barium ash/soil concentration of 180.7 mg/kg did not pass the second simulation of the VZCOMML© Tier II screen at the HAB OU with a predicted barium concentration of 5.64E+03 (action level is 2.00E+03 ug/L) reaching the aquifer in 402 years (Table B-8). For these reasons, barium was retained as a CM RCOC for the HAB OU. The Tier II $SSL_{T1/2}$ determined for barium at the HAB OU is 64.1 mg/kg (Table B-8).

Nickel – Nickel was detected in all nine samples with an average result of 12.2 mg/kg and a maximum detection of 15.5 mg/kg (Table B-13). The SRS maximum nickel background concentration is 27.0 mg/kg (WSRC 2006). The average nickel ash/soil concentration of 12.2 mg/kg did not pass the second simulation of the VZCOMML© Tier II screen with a predicted concentration of 3.90E+02 ug/L reaching the aquifer in 392 years (Table B-8). The Tier II $SSL_{T1/2}$ determined for nickel at the HAB OU is 12.2 mg/kg. Nickel was not retained as a CM RCOC for the HAB OU based on the following lines of evidence:

- The maximum and average concentrations are below the SRS maximum background concentration.
- Nickel is a naturally occurring constituent that is common in SRS background soils.
- The Tier II $SSL_{T1/2}$ for nickel is equivalent to the average detected concentration.

Uranium-233/234 – Uranium-233/234 was detected in all nine samples with an average result of 3.39 pCi/g and a maximum concentration of 6.72 pCi/g (Table B-13). The maximum detection is greater than the maximum SRS background uranium-233/234 activity concentration of 1.76 pCi/g (WSRC 2006). The average uranium-233/234 ash/soil activity concentration of 3.39 pCi/g did not pass the second simulation of the VZCOMML© Tier II screen with a predicted concentration of 50.4 pCi/L reaching the aquifer in 845 years (Table B-8). Due to the mentioned lines of evidence, uranium-233/234 was retained as a CM RCOC for the HAB OU. The Tier II $SSL_{T1/2}$ (i.e., CM PRG) determined for uranium-233/234 at the HAB OU is 0.67 pCi/g.

Uranium-235 – Uranium-235 was detected in one of the nine consolidated ash samples with an estimated result (J-qualified) of 0.56 pCi/g. For the estimated result, the minimum detectable activity (MDA) was 0.21 pCi/g and the range of uranium-235 MDAs for all nine consolidated samples was 0.21 pCi/g to 0.66 pCi/g. The detected result and the MDAs for all consolidated samples are greater than the maximum SRS background uranium-235 activity concentration of 0.17 pCi/g (WSRC 2006). For all nine samples in the consolidated dataset, the uranium-235 results were not sensitive enough to detect background levels. The detected result and the maximum SRS background uranium-235 result did not pass the VZCOMML© Tier II simulation screen, with predicted groundwater concentrations exceeding screening levels in the aquifer at 845 years. Due to the mentioned lines of evidence, uranium-235 was retained as a CM RCOC for the HAB OU. The Tier II $SSLT_{1/2}$ (i.e., CM PRG) determined for uranium-235 at the HAB OU is 3.36E-02 pCi/g.

Uranium-238 – Uranium-238 was detected in all nine samples with an average result of 3.37 pCi/g and a maximum concentration of 5.82 pCi/g (Table B-13). The maximum detection is greater than the maximum SRS background uranium-238 activity concentration of 1.90 pCi/g (WSRC 2006). The average uranium-238 ash/soil activity concentration of 3.37 pCi/g did not pass the second simulation of the VZCOMML© Tier II screen with a predicted concentration of 50.1 pCi/L reaching the aquifer in 845 years. Due to the mentioned lines of evidence, uranium-238 was retained as a CM RCOC for the HAB OU. The Tier II $SSL_{T1/2}$ (i.e., CM PRG) determined for uranium-238 at the HAB OU is 0.67 pCi/g

B-2.6.2. LAB OU Uncertainty Analysis

Barium – Barium was detected in all nine samples with an average result of 180.7 mg/kg and a maximum concentration of 479 mg/kg (Table B-13). The maximum SRS background barium concentration is 252 mg/kg (WSRC 2006). The average barium ash/soil concentration of 180.7 mg/kg did not pass the second simulation of the VZCOMML© Tier II screen at the LAB OU with a predicted barium concentration of 4.80E+03 (action level is 2.00E+03 ug/L) reaching the aquifer in 638 years (Table B-12). For these reasons, barium was retained as a CM RCOC for the LAB OU. The Tier II $SSL_{T1/2}$ determined for barium at the LAB OU is 75.3 mg/kg (Table B-12).

Nickel – Nickel was detected in all nine samples with an average result of 12.2 mg/kg and a maximum detection of 15.5 mg/kg (Table B-13). The SRS maximum nickel background concentration is 27.0 mg/kg (WSRC 2006). The average nickel ash/soil concentration of 12.2 mg/kg passed the second simulation of the VZCOMML© Tier II screen at the LAB OU with a predicted concentration of 3.32E+2 ug/L reaching the aquifer in 621 years (Table B-12). The Tier II $SSL_{T1/2}$ determined for nickel at the LAB OU is 14.3 mg/kg. Nickel was not retained as a CM RCOC for the LAB OU based on the following lines of evidence:

- The maximum and average concentrations are below the SRS maximum background concentration.
- Nickel is a naturally occurring constituent that is common in SRS background soils.
- The Tier II $SSL_{T1/2}$ for nickel is greater than the average detected concentration.

B-3. CONCLUSIONS

The remaining coal ash and coal fines OUs include the AAP OU, ACPRB OU, FAL OU, HAB OU, KAB OU, and LAB OU. CM analyses for the AAP OU and the ACPRB OU were completed in a previous effort and reported in *Appendix D – Contaminant Migration Analysis* of the approved *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit (U)* (SRNS 2012). There were no CM RCOCs identified for either the AAP OU or the ACPRB OU. Therefore, there are no CM PRGs applicable to the two A Area ash OUs.

The CM analysis performed using VZCOMML© identified CM RCOCs for the HAB OU (barium, uranium-233/234, uranium-235, uranium-238) and the LAB OU (barium) in the vadose zone with the potential to migrate to groundwater and exceed groundwater action levels within 1,000 yrs. Table B-14 summarizes the Tier I and Tier II Screening Results. The mean travel times calculated for the HAB OU CM RCOCs were 402 yrs for barium and 845 yrs for the uranium radionuclides. The mean travel time calculated for barium at the LAB OU was 638 yrs. CM PRGs for identified

CM RCOCs were determined using the highest Tier II SSL calculated for each OU and summarized in Table B-15.

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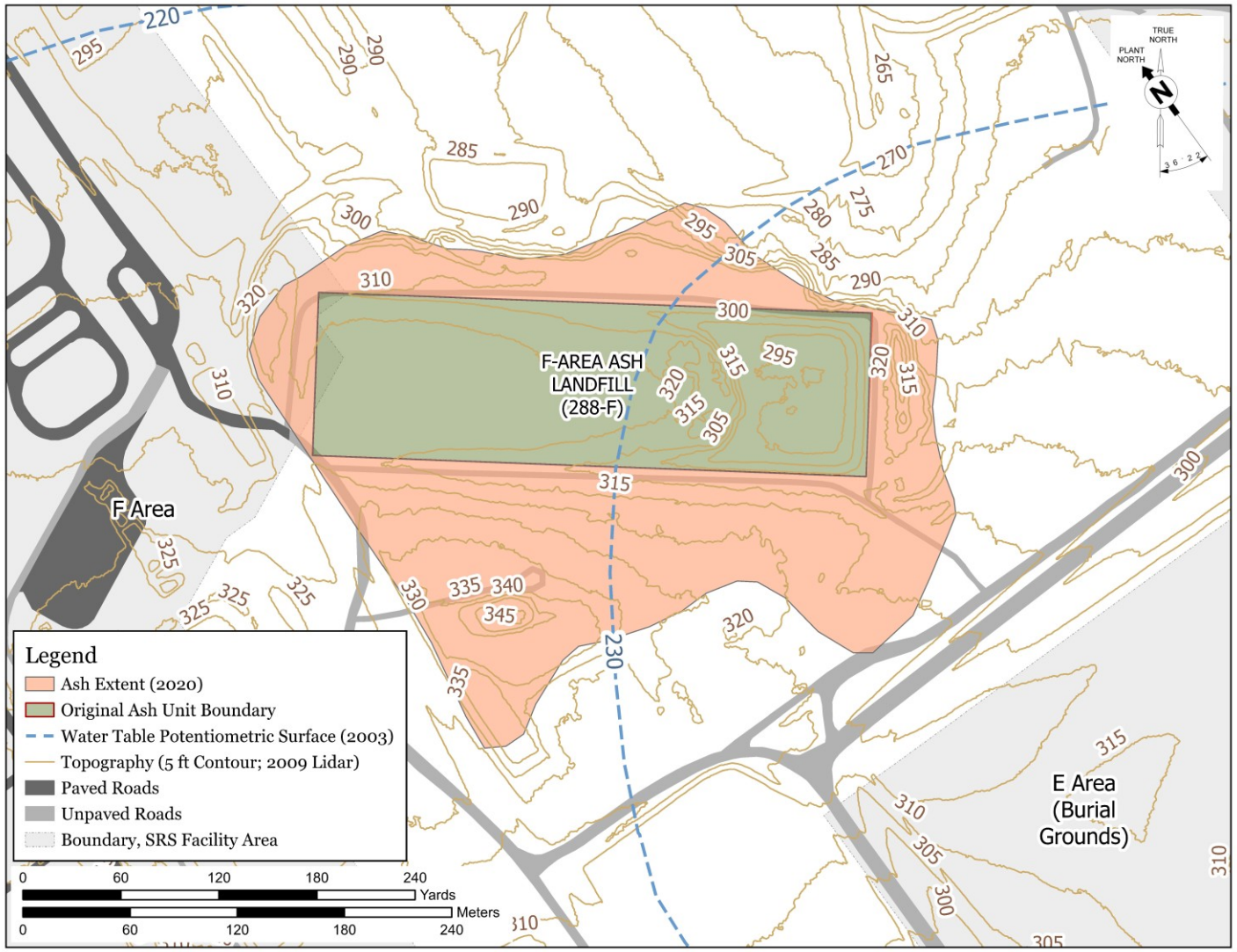


Figure B-1. F-Area Ash Landfill Operable Unit Ash Extent

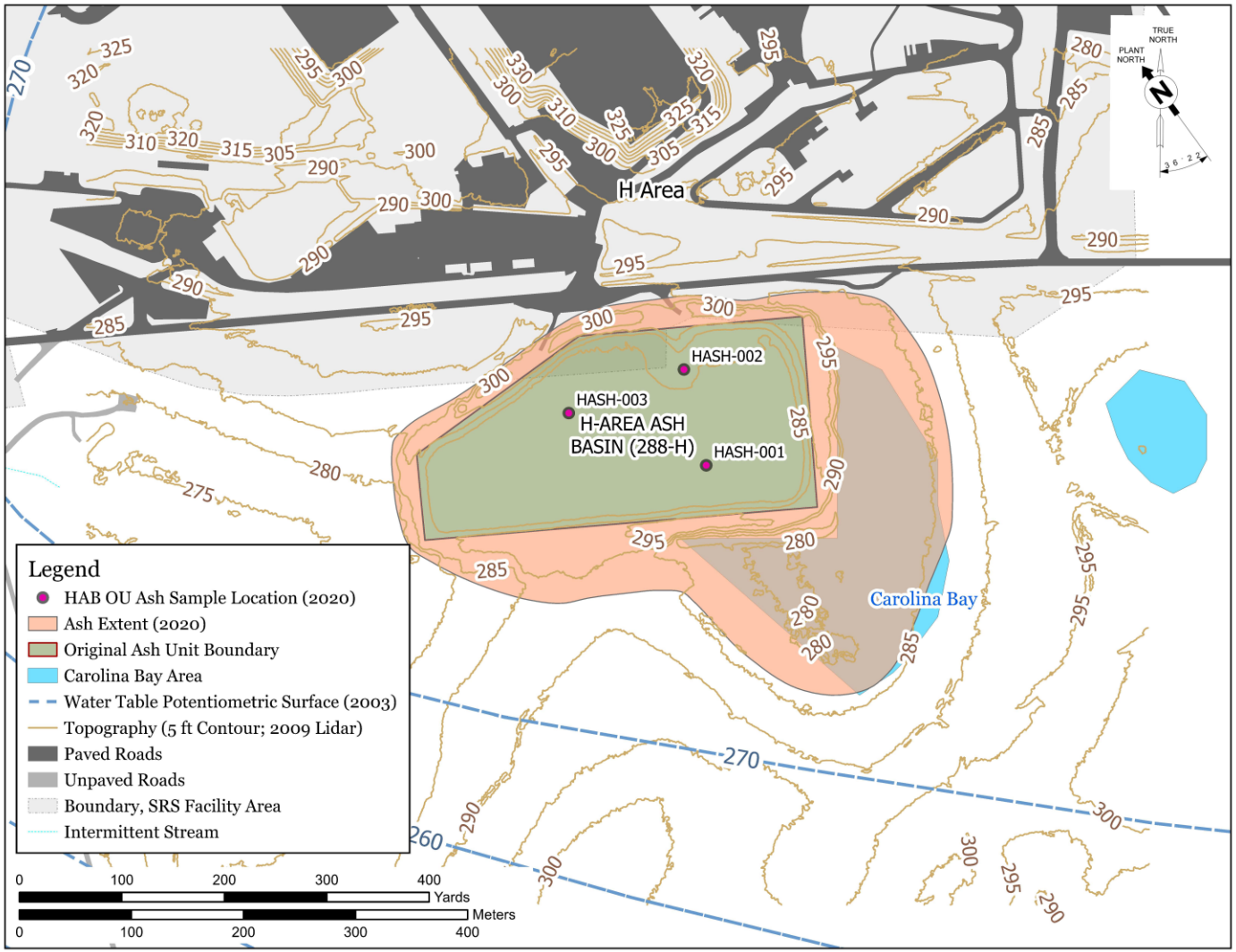


Figure B-2. H-Area Ash Basin Operable Unit Ash Extent

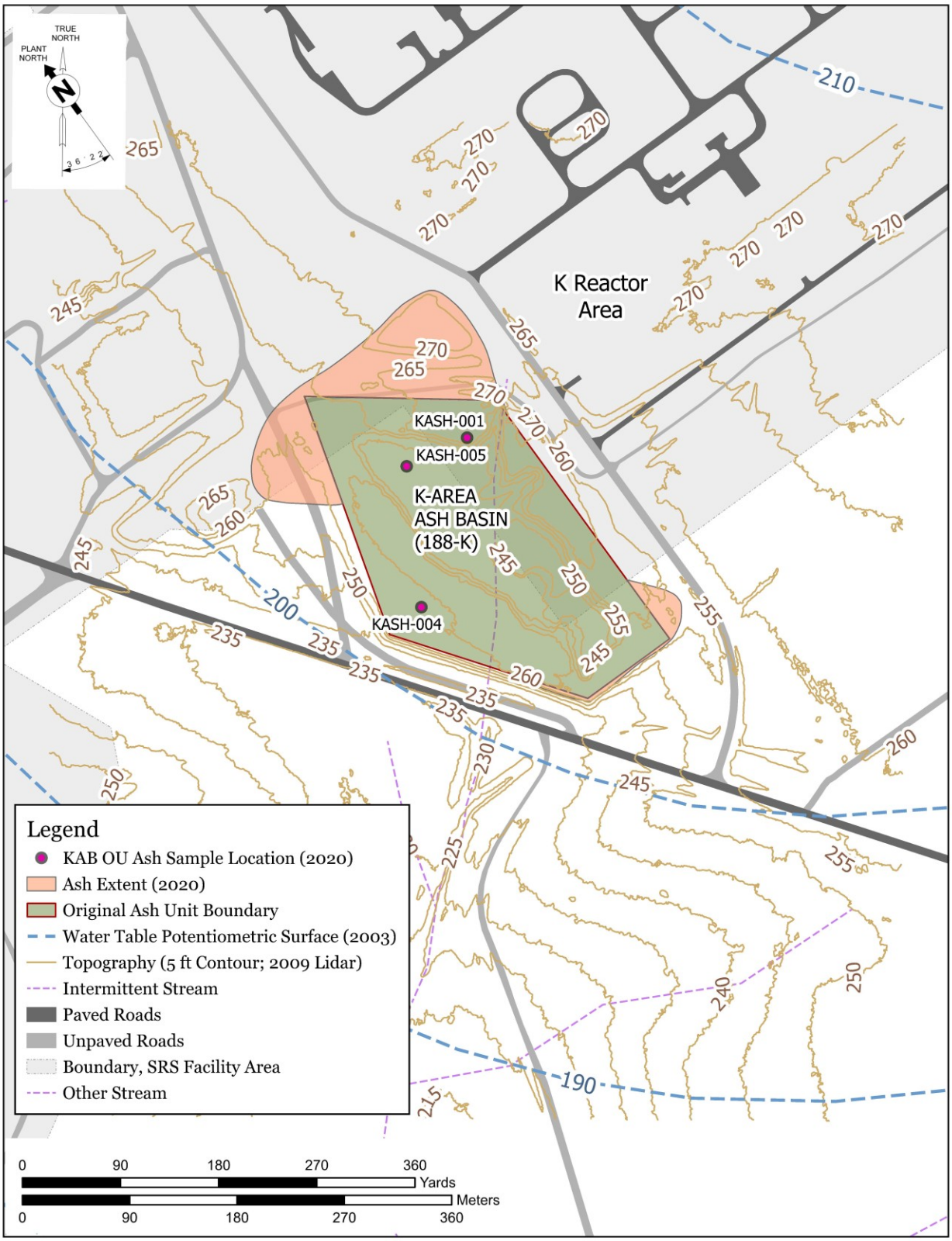


Figure B-3. K-Area Ash Basin Operable Unit Ash Extent

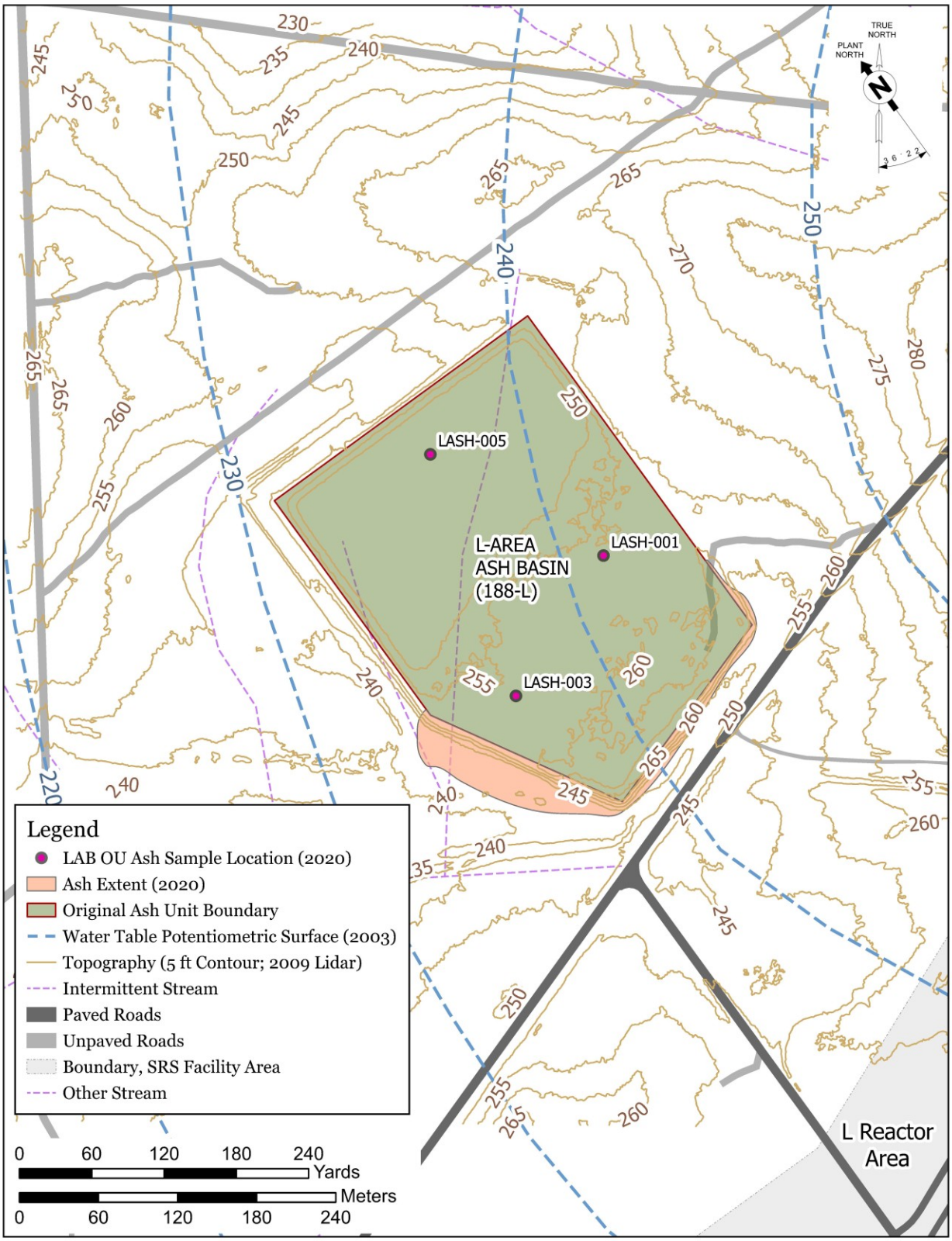


Figure B-4. L-Area Ash Basin Operable Unit Ash Extent

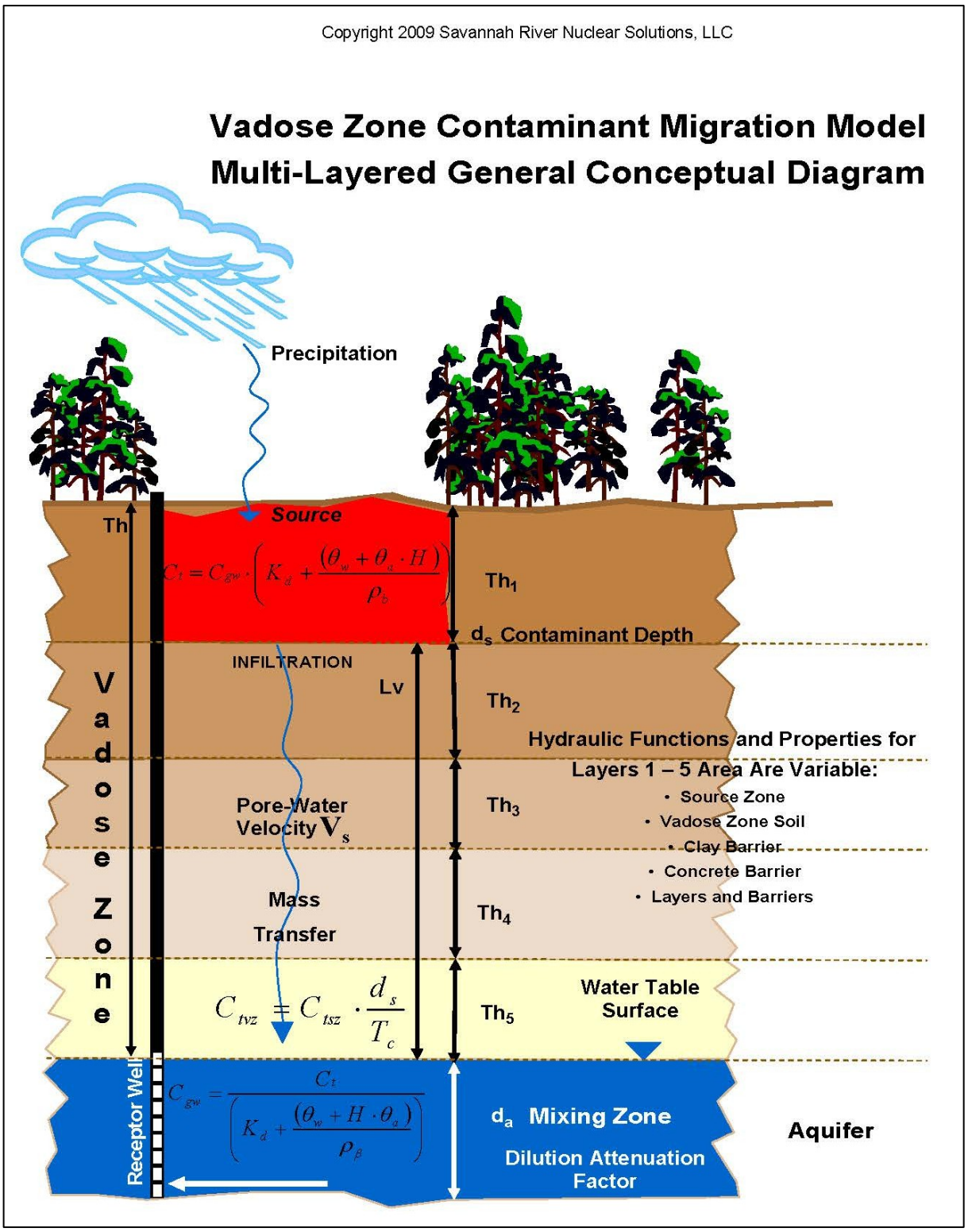


Figure B-5. VZCOMML© Contamination Migration Conceptual Diagram

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Table B-1. Chemical Parameters Used for Screening

Analyte	K_{OC} *[L/kg]*	K_d [A] *[L/kg]*	$T_{1/2}$ *[yr]*	H' *[-]*	S *[mg/L]*	Action Level [B] *[µg/L or pCi/L]*
Semi-Volatile Analytes						
2-Methylnaphthalene	7.94E+03	1.59E+01	1.32E-01	1.36E-02	2.54E+01	3.60E+01
Benzo(a)anthracene	3.58E+05	7.16E+02	1.86E+00	1.37E-04	9.40E-03	3.00E-02
Benzo(a)pyrene	9.69E+05	1.94E+03	1.45E+00	4.63E-05	1.62E-03	2.00E-01
Benzo(b)fluoranthene	1.23E+06	2.46E+03	1.67E+00	4.55E-03	1.50E-03	2.50E-01
Benzo(g,h,i)perylene	1.60E+06	3.20E+03	1.78E+00	5.13E-06	3.00E-04	NA
Bis(2-ethylhexyl) phthalate	1.11E+05	2.22E+02	6.30E-02	4.18E-06	3.40E-01	6.00E+00
Chrysene	3.98E+05	7.96E+02	2.72E+00	3.88E-03	1.60E-03	2.50E+01
Di-n-butyl phthalate	1.57E+03	3.14E+00	6.30E-02	3.85E-08	1.12E+01	9.00E+02
Fluoranthene	4.90E+04	9.80E+01	1.21E+00	6.60E-04	2.06E-01	8.00E+02
Indeno(1,2,3-c,d)pyrene	3.74E+06	7.48E+03	2.00E+00	6.56E-05	2.20E-05	2.50E-01
Naphthalene	1.19E+03	2.38E+00	1.32E-01	1.98E-02	3.10E+01	1.20E-01
Phenanthrene	1.40E+04	2.80E+01	5.48E-01	1.60E-03	1.29E+00	NA
Pyrene	6.80E+04	1.36E+02	5.20E+00	4.51E-04	1.35E-01	1.20E+02
Metal Analytes						
Aluminum	NA	1.00E+03	Infinite	NA	NA	2.00E+04
Arsenic, Inorganic	NA	1.50E+02	Infinite	NA	NA	1.00E+01
Barium	NA	1.90E+01	Infinite	NA	NA	2.00E+03
Beryllium and compounds	NA	7.90E+02	Infinite	NA	NA	4.00E+00
Calcium	NA	1.25E+01	Infinite	NA	NA	NA
Chromium, Total	NA	7.00E+02	Infinite	NA	NA	1.00E+02
Cobalt	NA	7.00E+01	Infinite	NA	NA	6.00E+00
Copper, Total	NA	6.00E+01	Infinite	NA	NA	1.30E+03
Iron	NA	3.00E+02	Infinite	NA	NA	1.40E+04
Lead and compounds	NA	3.50E+03	Infinite	NA	NA	1.50E+01

Table B-1. Chemical Parameters Used for Screening *(Continued/End)*

Analyte	K_{OC} *[L/kg]*	K_d [A] *[L/kg]*	$T_{1/2}$ *[yr]*	H' *[-]*	S *[mg/L]*	Action Level [B] *[µg/L or pCi/L]*
Magnesium	NA	NA	Infinite	NA	NA	NA
Manganese	NA	1.10E+02	Infinite	NA	NA	4.30E+02
Mercury (elemental)	NA	9.00E+02	Infinite	NA	NA	2.00E+00
Nickel	NA	1.85E+01	Infinite	NA	NA	3.90E+02
Potassium	NA	1.75E+01	Infinite	NA	NA	NA
Selenium	NA	1.00E+03	Infinite	NA	NA	5.00E+01
Sodium, total recoverable	NA	1.75E+01	Infinite	NA	NA	NA
Vanadium, total recoverable	NA	1.00E+03	Infinite	NA	NA	8.60E+01
Zinc (metallic)	NA	2.50E+01	Infinite	NA	NA	6.00E+03
Radiological Analytes						
Actinium-228	NA	4.50E+02	7.00E-04	NA	NA	2.66E+01
Cesium-137	NA	5.00E+02	3.02E+01	NA	NA	2.00E+02
Lead-212	NA	2.70E+02	1.20E-03	NA	NA	2.12E+00
Potassium-40	NA	7.50E+01	1.28E+09	NA	NA	2.14E+00
Radium-226	NA	1.00E+02	1.60E+03	NA	NA	5.00E+00
Radium-228	NA	1.00E+02	5.75E+00	NA	NA	5.00E+00
Thorium-228	NA	1.00E+02	1.91E+00	NA	NA	1.50E+01
Thorium-230	NA	1.00E+02	7.70E+04	NA	NA	1.50E+01
Thorium-232	NA	1.00E+02	1.41E+10	NA	NA	1.50E+01
Uranium-233/234	NA	4.00E+01	2.45E+05	NA	NA	1.00E+01
Uranium-235	NA	4.00E+01	7.04E+08	NA	NA	5.00E-01
Uranium-238	NA	4.00E+01	4.47E+09	NA	NA	1.00E+01

A K_d values for metals were updated with site specific data (Kaplan 2021).
B Action Level – The USEPA Regional Screening Level (RSL) was used when a MCL was not available.
NA = Not Available; Red = MCL; Black = RSL. May 2024 table revision on **www.epa.gov** website used.

Table B-2. Vadose Zone Layers for the Four Ash OUs

Subsurface Layer	Layer Type	Texture Classification[A]	Layer Thickness
F-Area Ash Landfill (288-F) Operable Unit			
1	Source	Sand	5.2 m (17 ft)
2	Soil	Loamy Sand	3.4 m (11 ft)
3	Soil	Sandy Clay	6.7 m (22 ft)
4	Soil	Sandy Loam	9.1 m (30 ft)
H-Area Ash Basin (288-H) Operable Unit			
1	Source	Sand	2.7 m (9 ft)
2	Soil	Sandy Clay	1.8 m (6 ft)
K-Area Ash Basin (188-K) Operable Unit			
1	Source	Sand	4.9 m (16 ft)
2	Soil	Sandy Clay Loam	6.1 m (20 ft)
3	Soil	Sandy Loam	3.0 m (10 ft)
4	Soil	Sandy Clay Loam	2.1 m (7 ft)
L-Area Ash Basin (188-L) Operable Unit			
1	Source	Sand	4.3 m (14 ft)
2	Soil	Sandy Loam	2.1 m (7 ft)
3	Soil	Sandy Clay Loam	0.91 m (3 ft)

A Texture classifications based on United States Department of Agriculture soil triangle and texture classifications.

Table B-3. General Physical Parameters Used for Screening

Parameter	Symbol	Value	Units	Reference
Infiltration rate	I	0.60	ft/yr	Infiltration rate for site specific soil type, calculated in VZCOMML© based on Horton's Method
Aquifer saturated horizontal hydraulic conductivity	K_a	755[A]	ft/yr	Horizontal hydraulic conductivity for a sandy loam
Aquifer thickness	d_a	10	ft	VZCOMML© Default; lower values are more conservative
Exposure duration	*ED*	70	yr	USEPA 2000
Evaluation time	T_e	1,000	yr	SRNS 2023a
Dry bulk density	ρ_b	1.7	kg/L	Rucker 2011
Fraction organic carbon	f_{oc}	0.002	Decimal fraction	Rucker 2011

A For the H-Area Ash Basin (288-H) Operable Unit, the aquifer soil classification was sandy clay loam, which has a hydraulic conductivity of 131 ft/yr.

Table B-4. Operable Unit Specific Model Parameters

Subunit	Depth of Contamination [A] *[ft bgs]*	Surface Depth to Water [B] *[ft bgs]*	Depth from Source to Water Table [C] *[ft]*	Source Length [D] *[ft]*	Horizontal Hydraulic Gradient [B] *[ft/ft]*	Dilution Attenuation Factor [E] *[-]*	Total Porosity [E] *[-]*	Table(s)
FAL OU	17	80	63	1300	0.004	1.04	0.41	5,6
HAB OU	9	15	6	1550	0.003	1.00	0.41	7,8
KAB OU	16	53	37	730	0.005	1.09	0.41	9,10
LAB OU	14	24	10	1100	0.013	1.15	0.42	11,12

bgs – below ground surface

[A] Depth of contamination based on the thickest estimate of ash for each OU

[B] Determined conservatively based on potentiometric surface generated using 2003 synchronous water level data (or most recent data available)

[C] Calculated from depth to water and depth of contamination measurements

[D] Estimated conservatively based on aerial extent of contamination (including extended boundary based on visual ash observations) and length parallel to 2003 regional groundwater flow direction

[E] Calculated within the VZCOMML©

Table B-5. Tier I Screening Results for the FAL OU

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
2-Methylnaphthalene	4.15E-01	5.99E-01	5.43E-02	
Benzo(a)anthracene	3.26E-02	2.23E-02	4.53E-05	Benzo(a)anthracene
Benzo(a)pyrene	1.52E-02	4.03E-01	3.02E-04	
Benzo(b)fluoranthene	3.75E-02	6.39E-01	3.77E-04	
Benzo(g,h,i)perylene	2.97E-02	NA	NA	
Bis(2-ethylhexyl) phthalate	1.65E-02	1.38E+00	9.06E-03	
Chrysene	3.51E-02	2.07E+01	3.77E-02	
Di-n-butyl phthalate	2.46E-02	3.07E+00	1.36E+00	
Fluoranthene	4.97E-02	8.16E+01	1.21E+00	
Indeno(1,2,3-c,d)pyrene	1.30E-02	1.94E+00	3.77E-04	
Naphthalene	2.60E-01	3.15E-04	1.81E-04	Naphthalene
Phenanthrene	2.28E-01	NA	NA	
Pyrene	6.42E-02	1.70E+01	1.81E-01	
Aluminum	2.16E+04	2.08E+04	3.02E+01	Aluminum
Arsenic, Inorganic	7.65E+01	1.56E+00	1.51E-02	Arsenic, Inorganic
Barium	4.79E+02	3.98E+01	3.02E+00	Barium
Beryllium and compounds	5.06E+00	3.28E+00	6.04E-03	Beryllium and compounds
Calcium	4.59E+04	NA	NA	
Chromium, Total	1.87E+01	7.27E+01	1.51E-01	
Cobalt	1.01E+01	4.37E-01	9.06E-03	Cobalt
Copper, Total	3.90E+01	8.12E+01	1.96E+00	
Iron	2.16E+04	4.36E+03	2.11E+01	Iron
Lead and compounds	1.25E+01	5.45E+01	2.26E-02	

Table B-5. Tier I Screening Results for the FAL OU *(Continued/End)*

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
Magnesium	5.44E+03	NA	NA	
Manganese	2.30E+02	4.92E+01	6.49E-01	Manganese
Mercury (elemental)	1.03E-01	1.87E+00	3.02E-03	
Nickel	1.55E+01	7.55E+00	5.89E-01	Nickel
Potassium	1.95E+03	NA	NA	
Selenium	3.09E+00	5.19E+01	7.55E-02	
Sodium, total recoverable	5.92E+02	NA	NA	
Vanadium, total recoverable	4.88E+01	8.93E+01	1.30E-01	
Zinc (metallic)	2.67E+01	1.57E+02	9.06E+00	
Actinium-228	4.15E+00	3.69E+05	1.19E+03	
Cesium-137	2.26E-01	1.44E+02	4.18E-01	
Lead-212	3.55E+00	1.03E+04	5.54E+01	
Potassium-40	1.25E+01	1.67E-01	3.23E-03	Potassium-40
Radium-226	8.63E+00	5.23E-01	7.60E-03	Radium-226
Radium-228	1.10E+00	1.93E+00	2.80E-02	
Thorium-228	4.27E+00	1.70E+01	2.46E-01	
Thorium-230	8.02E+00	1.56E+00	2.26E-02	Thorium-230
Thorium-232	3.90E+00	1.56E+00	2.26E-02	Thorium-232
Uranium-233/234	6.72E+00	4.17E-01	1.51E-02	Uranium-233/234
Uranium-235	5.61E-01	2.08E-02	7.55E-04	Uranium-235
Uranium-238	5.82E+00	4.17E-01	1.51E-02	Uranium-238

NA – not applicable

Table B-6. Tier II Simulation Results for the FAL OU

Analyte	Retardation	Mean Travel Time	Predicted Concentration in Aquifer	Action Level	Failing Analytes	Tier II $SSL_{T1/2}$	Tier II $MLSSL_{T1/2}$
	[unitless]	*[years]*	*[µg/L or pCi/L]*			*[mg/kg or pCi/g]*	
Benzo(a)anthracene	6.19E+03	1.57E+05		3.00E-02		Infinite	Infinite
Naphthalene	2.16E+01	5.46E+02		1.20E-01		Infinite	Infinite
Aluminum	8.65E+03	2.19E+05	4.42E+03	2.00E+04		9.78E+04	N/A
Arsenic, Inorganic	1.30E+03	3.29E+04	1.04E+02	1.00E+01		7.34E+00	N/A
Barium	1.65E+02	4.18E+03	5.12E+03	2.00E+03		1.87E+02	N/A
Beryllium and compounds	6.83E+03	1.73E+05	1.31E+00	4.00E+00		1.54E+01	N/A
Cobalt	6.06E+02	1.53E+04	2.95E+01	6.00E+00		2.06E+00	N/A
Iron	2.60E+03	6.57E+04	1.47E+04	1.40E+04		2.05E+04	N/A
Manganese	9.52E+02	2.41E+04	4.27E+02	4.30E+02		2.32E+02	N/A
Nickel	1.61E+02	4.08E+03	1.70E+02	3.90E+02		3.55E+01	N/A
Potassium-40	6.50E+02	1.64E+04	3.40E+01	2.14E+00		7.86E-01	3.23E-03
Radium-226	8.66E+02	2.19E+04	1.32E-03	5.00E+00		3.27E+04	7.83E-03
Thorium-230	8.66E+02	2.19E+04	1.34E+01	1.50E+01		8.94E+00	2.27E-02
Thorium-232	8.66E+02	2.19E+04	7.97E+00	1.50E+01		7.34E+00	2.26E-02
Uranium-233/234	3.47E+02	8.78E+03	3.34E+01	1.00E+01		2.01E+00	1.51E-02
Uranium-235	3.47E+02	8.78E+03	2.86E+00	5.00E-01		9.81E-02	7.55E-04
Uranium-238	3.47E+02	8.78E+03	2.97E+01	1.00E+01		1.96E+00	1.51E-02

Table B-7. Tier I Screening Results for the HAB OU

Analyte	Maximum Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
2-Methylnaphthalene	4.15E-01	5.79E-01	9.92E-02	
Benzo(a)anthracene	3.26E-02	2.16E-02	8.27E-05	Benzo(a)anthracene
Benzo(a)pyrene	1.52E-02	3.89E-01	5.51E-04	
Benzo(b)fluoranthene	3.75E-02	6.18E-01	6.89E-04	
Benzo(g,h,i)perylene	2.97E-02	NA	NA	
Bis(2-ethylhexyl) phthalate	1.65E-02	1.34E+00	1.65E-02	
Chrysene	3.51E-02	2.00E+01	6.89E-02	
Di-n-butyl phthalate	2.46E-02	2.96E+00	2.48E+00	
Fluoranthene	4.97E-02	7.88E+01	2.21E+00	
Indeno(1,2,3-c,d)pyrene	1.30E-02	1.88E+00	6.89E-04	
Naphthalene	2.60E-01	3.03E-04	3.31E-04	Naphthalene
Phenanthrene	2.28E-01	NA	NA	
Pyrene	6.42E-02	1.64E+01	3.31E-01	
Aluminum	2.16E+04	2.01E+04	5.51E+01	Aluminum
Arsenic, Inorganic	7.65E+01	1.51E+00	2.76E-02	Arsenic, Inorganic
Barium	4.79E+02	3.84E+01	5.51E+00	Barium
Beryllium and compounds	5.06E+00	3.17E+00	1.10E-02	Beryllium and compounds
Calcium	4.59E+04	NA	NA	
Chromium, Total	1.87E+01	7.03E+01	2.76E-01	
Cobalt	1.01E+01	4.23E-01	1.65E-02	Cobalt
Copper, Total	3.90E+01	7.85E+01	3.58E+00	
Iron	2.16E+04	4.22E+03	3.86E+01	Iron

Table B-7. Tier I Screening Results for the HAB OU *(Continued/End)*

Analyte	Maximum Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
Lead and compounds	1.25E+01	5.27E+01	4.14E-02	
Magnesium	5.44E+03	NA	NA	
Manganese	2.30E+02	4.76E+01	1.19E+00	Manganese
Mercury (elemental)	1.03E-01	1.81E+00	5.51E-03	
Nickel	1.55E+01	7.30E+00	1.08E+00	Nickel
Potassium	1.95E+03	NA	NA	
Selenium	3.09E+00	5.02E+01	1.38E-01	
Sodium, total recoverable	5.92E+02	NA	NA	
Vanadium, total recoverable	4.88E+01	8.64E+01	2.37E-01	
Zinc (metallic)	2.67E+01	1.51E+02	1.65E+01	
Actinium-228	4.15E+00	3.57E+05	2.18E+03	
Cesium-137	2.26E-01	1.39E+02	7.63E-01	
Lead-212	3.55E+00	9.96E+03	1.01E+02	
Potassium-40	1.25E+01	1.61E-01	5.90E-03	Potassium-40
Radium-226	8.63E+00	5.06E-01	1.39E-02	Radium-226
Radium-228	1.10E+00	1.87E+00	5.12E-02	
Thorium-228	4.27E+00	1.64E+01	4.50E-01	
Thorium-230	8.02E+00	1.51E+00	4.14E-02	Thorium-230
Thorium-232	3.90E+00	1.51E+00	4.14E-02	Thorium-232
Uranium-233/234	6.72E+00	4.03E-01	2.76E-02	Uranium-233/234
Uranium-235	5.61E-01	2.02E-02	1.38E-03	Uranium-235
Uranium-238	5.82E+00	4.03E-01	2.76E-02	Uranium-238

NA – not applicable

Table B-8. Tier II Simulation Results for the HAB OU

Analyte	Retardation	Mean Travel Time	Predicted Concentration in Aquifer	Action Level	Failing Analytes	Tier II $SSL_{T1/2}$	Tier II $MLSSL_{T1/2}$
	[unitless]	*[years]*	*[µg/L or pCi/L]*			*[mg/kg or pCi/g]*	
Simulation 1 – Input Maximum Detects							
Benzo(a)anthracene	6.61E+03	1.51E+04		3.00E-02		Infinite	Infinite
Naphthalene	2.30E+01	5.24E+01		1.20E-01		Infinite	Infinite
Aluminum	9.23E+03	2.11E+04	1.29E+04	2.00E+04		3.35E+04	N/A
Arsenic, Inorganic	1.39E+03	3.16E+03	3.04E+02	1.00E+01		2.51E+00	N/A
Barium	1.76E+02	4.02E+02	1.50E+04	2.00E+03	Barium	6.41E+01	N/A
Beryllium and compounds	7.29E+03	1.66E+04	3.83E+00	4.00E+00		5.29E+00	N/A
Cobalt	6.47E+02	1.48E+03	8.60E+01	6.00E+00		7.04E-01	N/A
Iron	2.77E+03	6.32E+03	4.30E+04	1.40E+04		7.03E+03	N/A
Manganese	1.02E+03	2.32E+03	1.25E+03	4.30E+02		7.93E+01	N/A
Nickel	1.72E+02	3.92E+02	4.97E+02	3.90E+02	Nickel	1.22E+01	N/A
Potassium-40	6.93E+02	1.58E+03	9.94E+01	2.14E+00		2.69E-01	5.90E-03
Radium-226	9.24E+02	2.11E+03	2.05E+01	5.00E+00		2.10E+00	1.43E-02
Thorium-230	9.24E+02	2.11E+03	4.69E+01	1.50E+01		2.56E+00	4.14E-02
Thorium-232	9.24E+02	2.11E+03	2.33E+01	1.50E+01		2.51E+00	4.14E-02
Uranium-233/234	3.70E+02	8.45E+02	9.98E+01	1.00E+01	Uranium-233/234	6.73E-01	2.76E-02
Uranium-235	3.70E+02	8.45E+02	8.35E+00	5.00E-01	Uranium-235	3.36E-02	1.38E-03
Uranium-238	3.70E+02	8.45E+02	8.66E+01	1.00E+01	Uranium-238	6.72E-01	2.76E-02
Simulation 2 – Input Average Detects							
Barium	1.76E+02	4.02E+02	5.64E+03	2.00E+03	Barium	6.41E+01	N/A
Nickel	1.72E+02	3.92E+02	3.90E+02	3.90E+02	Nickel	1.22E+01	N/A
Uranium-233/234	3.70E+02	8.45E+02	5.04E+01	1.00E+01	Uranium-233/234	6.73E-01	2.76E-02
Uranium-238	3.70E+02	8.45E+02	5.01E+01	1.00E+01	Uranium-238	6.72E-01	2.76E-02

Table B-9. Tier I Screening Results for the KAB OU

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
2-Methylnaphthalene	4.15E-01	6.27E-01	6.04E-02	
Benzo(a)anthracene	3.26E-02	2.33E-02	5.03E-05	Benzo(a)anthracene
Benzo(a)pyrene	1.52E-02	4.21E-01	3.35E-04	
Benzo(b)fluoranthene	3.75E-02	6.68E-01	4.19E-04	
Benzo(g,h,i)perylene	2.97E-02	NA	NA	
Bis(2-ethylhexyl) phthalate	1.65E-02	1.45E+00	1.01E-02	
Chrysene	3.51E-02	2.16E+01	4.19E-02	
Di-n-butyl phthalate	2.46E-02	3.21E+00	1.51E+00	
Fluoranthene	4.97E-02	8.53E+01	1.34E+00	
Indeno(1,2,3-c,d)pyrene	1.30E-02	2.03E+00	4.19E-04	
Naphthalene	2.60E-01	3.29E-04	2.01E-04	Naphthalene
Phenanthrene	2.28E-01	NA	NA	
Pyrene	6.42E-02	1.77E+01	2.01E-01	
Aluminum	2.16E+04	2.17E+04	3.35E+01	
Arsenic, Inorganic	7.65E+01	1.63E+00	1.68E-02	Arsenic, Inorganic
Barium	4.79E+02	4.16E+01	3.35E+00	Barium
Beryllium and compounds	5.06E+00	3.43E+00	6.71E-03	Beryllium and compounds
Calcium	4.59E+04	NA	NA	
Chromium, Total	1.87E+01	7.60E+01	1.68E-01	
Cobalt	1.01E+01	4.57E-01	1.01E-02	Cobalt
Copper, Total	3.90E+01	8.49E+01	2.18E+00	
Iron	2.16E+04	4.56E+03	2.35E+01	Iron
Lead and compounds	1.25E+01	5.70E+01	2.52E-02	

Table B-9. Tier I Screening Results for the KAB OU *(Continued/End)*

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
Magnesium	5.44E+03	NA	NA	
Manganese	2.30E+02	5.14E+01	7.21E-01	Manganese
Mercury (elemental)	1.03E-01	1.96E+00	3.35E-03	
Nickel	1.55E+01	7.90E+00	6.54E-01	Nickel
Potassium	1.95E+03	NA	NA	
Selenium	3.09E+00	5.43E+01	8.39E-02	
Sodium, total recoverable	5.92E+02	NA	NA	
Vanadium, total recoverable	4.88E+01	9.34E+01	1.44E-01	
Zinc (metallic)	2.67E+01	1.64E+02	1.01E+01	
Actinium-228	4.15E+00	3.86E+05	1.33E+03	
Cesium-137	2.26E-01	1.50E+02	4.64E-01	
Lead-212	3.55E+00	1.08E+04	6.16E+01	
Potassium-40	1.25E+01	1.75E-01	3.59E-03	Potassium-40
Radium-226	8.63E+00	5.47E-01	8.44E-03	Radium-226
Radium-228	1.10E+00	2.02E+00	3.12E-02	
Thorium-228	4.27E+00	1.78E+01	2.74E-01	
Thorium-230	8.02E+00	1.63E+00	2.52E-02	Thorium-230
Thorium-232	3.90E+00	1.63E+00	2.52E-02	Thorium-232
Uranium-233/234	6.72E+00	4.36E-01	1.68E-02	Uranium-233/234
Uranium-235	5.61E-01	2.18E-02	8.39E-04	Uranium-235
Uranium-238	5.82E+00	4.36E-01	1.68E-02	Uranium-238

NA – not applicable

Table B-10. Tier II Simulation Results for the KAB OU

Analyte	Retardation	Mean Travel Time	Predicted Concentration in Aquifer	Action Level	Failing Analytes	Tier II $SSL_{T1/2}$	Tier II $MLSSL_{T1/2}$
	[unitless]	*[years]*	*[µg/L or pCi/L]*			*[mg/kg or pCi/g]*	
Benzo(a)anthracene	6.35E+03	9.48E+04		3.00E-02		Infinite	Infinite
Naphthalene	2.21E+01	3.30E+02		1.20E-01		Infinite	Infinite
Arsenic, Inorganic	1.33E+03	1.99E+04	1.42E+02	1.00E+01		5.40E+00	N/A
Barium	1.70E+02	2.53E+03	6.95E+03	2.00E+03		1.38E+02	N/A
Beryllium and compounds	7.01E+03	1.05E+05	1.78E+00	4.00E+00		1.14E+01	N/A
Cobalt	6.22E+02	9.28E+03	4.00E+01	6.00E+00		1.51E+00	N/A
Iron	2.66E+03	3.97E+04	2.00E+04	1.40E+04		1.51E+04	N/A
Manganese	9.77E+02	1.46E+04	5.80E+02	4.30E+02		1.70E+02	N/A
Nickel	1.65E+02	2.46E+03	2.31E+02	3.90E+02		2.62E+01	N/A
Potassium-40	6.67E+02	9.94E+03	4.62E+01	2.14E+00		5.79E-01	3.59E-03
Radium-226	8.88E+02	1.33E+04	7.65E-02	5.00E+00		5.64E+02	8.70E-03
Thorium-230	8.88E+02	1.33E+04	1.98E+01	1.50E+01		6.09E+00	2.52E-02
Thorium-232	8.88E+02	1.33E+04	1.08E+01	1.50E+01		5.40E+00	2.52E-02
Uranium-233/234	3.56E+02	5.31E+03	4.58E+01	1.00E+01		1.47E+00	1.68E-02
Uranium-235	3.56E+02	5.31E+03	3.88E+00	5.00E-01		7.22E-02	8.39E-04
Uranium-238	3.56E+02	5.31E+03	4.03E+01	1.00E+01		1.44E+00	1.68E-02

Table B-11. Tier I Screening Results for the LAB OU

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
2-Methylnaphthalene	4.15E-01	6.62E-01	7.30E-02	
Benzo(a)anthracene	3.26E-02	2.47E-02	6.08E-05	Benzo(a)anthracene
Benzo(a)pyrene	1.52E-02	4.45E-01	4.05E-04	
Benzo(b)fluoranthene	3.75E-02	7.06E-01	5.07E-04	
Benzo(g,h,i)perylene	2.97E-02	NA	NA	
Bis(2-ethylhexyl) phthalate	1.65E-02	1.53E+00	1.22E-02	
Chrysene	3.51E-02	2.29E+01	5.07E-02	
Di-n-butyl phthalate	2.46E-02	3.37E+00	1.82E+00	
Fluoranthene	4.97E-02	9.02E+01	1.62E+00	
Indeno(1,2,3-c,d)pyrene	1.30E-02	2.15E+00	5.07E-04	
Naphthalene	2.60E-01	3.45E-04	2.43E-04	Naphthalene
Phenanthrene	2.28E-01	NA	NA	
Pyrene	6.42E-02	1.88E+01	2.43E-01	
Aluminum	2.16E+04	2.30E+04	4.05E+01	
Arsenic, Inorganic	7.65E+01	1.72E+00	2.03E-02	Arsenic, Inorganic
Barium	4.79E+02	4.39E+01	4.05E+00	Barium
Beryllium and compounds	5.06E+00	3.63E+00	8.11E-03	Beryllium and compounds
Calcium	4.59E+04	NA	NA	
Chromium, Total	1.87E+01	8.04E+01	2.03E-01	
Cobalt	1.01E+01	4.83E-01	1.22E-02	Cobalt
Copper, Total	3.90E+01	8.98E+01	2.64E+00	
Iron	2.16E+04	4.83E+03	2.84E+01	Iron
Lead and compounds	1.25E+01	6.03E+01	3.04E-02	

Table B-11. Tier I Screening Results for the LAB OU *(Continued/End)*

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	[mg/kg or pCi/g]			
Magnesium	5.44E+03	NA	NA	
Manganese	2.30E+02	5.44E+01	8.72E-01	Manganese
Mercury (elemental)	1.03E-01	2.07E+00	4.05E-03	
Nickel	1.55E+01	8.34E+00	7.91E-01	Nickel
Potassium	1.95E+03	NA	NA	
Selenium	3.09E+00	5.74E+01	1.01E-01	
Sodium, total recoverable	5.92E+02	NA	NA	
Vanadium, total recoverable	4.88E+01	9.88E+01	1.74E-01	
Zinc (metallic)	2.67E+01	1.73E+02	1.22E+01	
Actinium-228	4.15E+00	4.08E+05	1.60E+03	
Cesium-137	2.26E-01	1.59E+02	5.61E-01	
Lead-212	3.55E+00	1.14E+04	7.45E+01	
Potassium-40	1.25E+01	1.85E-01	4.34E-03	Potassium-40
Radium-226	8.63E+00	5.79E-01	1.02E-02	Radium-226
Radium-228	1.10E+00	2.14E+00	3.77E-02	
Thorium-228	4.27E+00	1.88E+01	3.31E-01	
Thorium-230	8.02E+00	1.73E+00	3.04E-02	Thorium-230
Thorium-232	3.90E+00	1.73E+00	3.04E-02	Thorium-232
Uranium-233/234	6.72E+00	4.61E-01	2.03E-02	Uranium-233/234
Uranium-235	5.61E-01	2.30E-02	1.01E-03	Uranium-235
Uranium-238	5.82E+00	4.61E-01	2.03E-02	Uranium-238

NA – not applicable

Table B-12. Tier II Simulation Results for the LAB OU

Analyte	Retardation	Mean Travel Time	Predicted Concentration in Aquifer	Action Level	Failing Analytes	Tier II $SSL_{T1/2}$	Tier II $MLSSL_{T1/2}$
	[unitless]	*[years]*	*[µg/L or pCi/L]*			*[mg/kg or pCi/g]*	
Simulation 1 – Input Maximum Detects							
Benzo(a)anthracene	7.01E+03	2.39E+04		3.00E-02		Infinite	Infinite
Naphthalene	2.43E+01	8.29E+01		1.20E-01		Infinite	Infinite
Arsenic, Inorganic	1.47E+03	5.01E+03	2.59E+02	1.00E+01		2.96E+00	N/A
Barium	1.87E+02	6.38E+02	1.27E+04	2.00E+03	Barium	7.53E+01	N/A
Beryllium and compounds	7.73E+03	2.64E+04	3.25E+00	4.00E+00		6.22E+00	N/A
Cobalt	6.86E+02	2.34E+03	7.31E+01	6.00E+00		8.28E-01	N/A
Iron	2.94E+03	1.00E+04	3.65E+04	1.40E+04		8.27E+03	N/A
Manganese	1.08E+03	3.68E+03	1.06E+03	4.30E+02		9.32E+01	N/A
Nickel	1.82E+02	6.21E+02	4.23E+02	3.90E+02	Nickel	1.43E+01	N/A
Potassium-40	7.35E+02	2.51E+03	8.45E+01	2.14E+00		3.17E-01	4.34E-03
Radium-226	9.79E+02	3.34E+03	1.02E+01	5.00E+00		4.22E+00	1.05E-02
Thorium-230	9.79E+02	3.34E+03	3.95E+01	1.50E+01		3.05E+00	3.04E-02
Thorium-232	9.79E+02	3.34E+03	1.98E+01	1.50E+01		2.96E+00	3.04E-02
Uranium-233/234	3.92E+02	1.34E+03	8.47E+01	1.00E+01		7.93E-01	2.03E-02
Uranium-235	3.92E+02	1.34E+03	7.10E+00	5.00E-01		3.95E-02	1.01E-03
Uranium-238	3.92E+02	1.34E+03	7.37E+01	1.00E+01		7.90E-01	2.03E-02
Simulation 2 – Input Average Detects							
Barium	1.87E+02	6.38E+02	4.80E+03	2.00E+03	Barium	7.53E+01	N/A
Nickel	1.82E+02	6.21E+02	3.32E+02	3.90E+02		1.43E+01	N/A

Table B-13. Result Summary for Identified CM COCs

Analyte Name	Units	# of Samples	# of Non-detects	# of Detects	# of J-Detects	Average of Detects	Max Detect	Location of Max	Max Detect in Each Basin		
									HAB OU	KAB OU	LAB OU
Barium	mg/kg	9	0	9	0	180.7	479	LASH-001	227	179	479
Nickel	mg/kg	9	0	9	0	12.17	15.5	HASH-001	15.5	13.8	14.4
Uranium-233/234	pCi/g	9	0	9	1	3.393	6.72	LASH-001	3.38	3.77	6.72
Uranium-235	pCi/g	9	8	1	1	0.272	0.561	LASH-001	ND	ND	0.561
Uranium-238	pCi/g	9	0	9	1	3.366	5.82	LASH-001	3.59	3.70	5.82

J-Detects refer to J qualified, or estimated, records where results were detected below the practical quantitation limit.

ND - no detections

Table B-14. Summary Table of Tier I and Tier II Screening Results

OU Subunit	# of Tier I CM COPCs	Tier I CM COPCs	Tier II CM COCs	CM RCOCs
FAL OU	17	Benzo(a)anthracene, Naphthalene, Aluminum, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	None	None
HAB OU	17	Benzo(a)anthracene, Naphthalene, Aluminum, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	Barium, Nickel, Uranium-233/234, Uranium-235, Uranium-238	Barium, Uranium-233/234, Uranium-235, Uranium-238
KAB OU	16	Benzo(a)anthracene, Naphthalene, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	None	None
LAB OU	16	Benzo(a)anthracene, Naphthalene, Arsenic, Barium, Beryllium, Cobalt, Iron, Manganese, Nickel, Potassium-40, Radium-226, Thorium-230, Thorium-232, Uranium-233/234, Uranium-235, Uranium-238	Barium, Nickel	Barium

Table B-15. Summary of CM PRGs

CM RCOC	CM PRG	SRS Maximum Background	Units
HAB OU			
Barium	64.1	252	mg/kg
Uranium-233/234	0.67	1.76	pCi/g
Uranium-235	0.03	0.17	pCi/g
Uranium-238	0.67	1.90	pCi/g
LAB OU			
Barium	75.3	252	mg/kg

Attachment B-1

FAC-1P Lithology

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OSR 30-5
(Rev 12-89)

MONITORING WELL CONSTRUCTION DIAGRAM

DRILLING SUBCONTRACTOR EMTC

DRILLER T. Hornsby

DATE OF WELL INSTALLATION 1-22-91

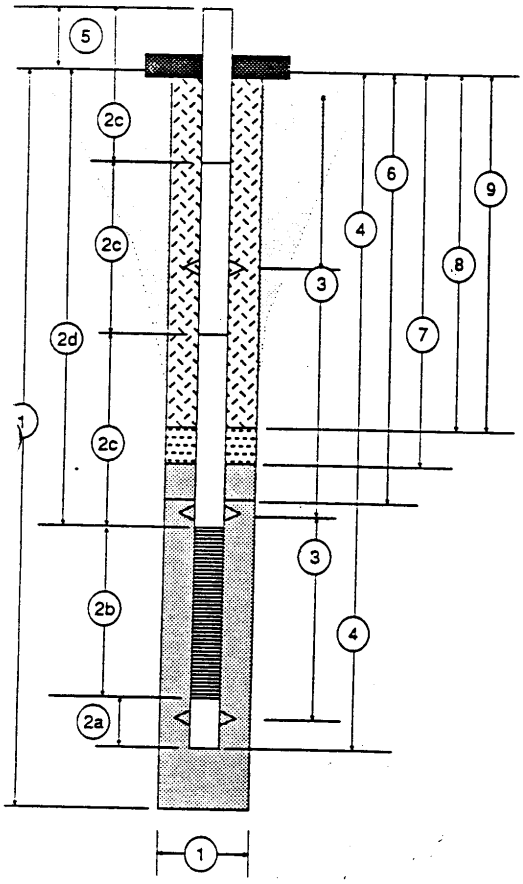
TECH. O.S./CO. NAME M. Hudgins / AT+E

WELL NUMBER FAC- 1P

SRS COORDINATES ~~N77,987.71~~ 77,989.45 E ~~55,258.08~~ 55,258.21

SANITARY SEAL ELEVATION ~~240.7~~ 314.54

NOTE: ALL MEASUREMENTS ARE FROM GROUND SURFACE AT START OF BORING – MEASUREMENTS TO NEAREST 0.1 FOOT.



1) Total Drilled Depth/Hole Diameter 87.0 ft / 7 7/8 in

2) Casing/Screen Tally (Measured to Nearest 0.01 Foot)

(a) Sump & Plug Length 0.32 ft

(b) Screen Length 10.02 ft.

(c) Casing Joint Lengths (Measured in Up-hole Sequence From Top of Screen) (1) 10.01
(2) 10.01 (3) 10.01 (4) 10.01 (5) 10.01
(6) 10.02 (7) 10.01 (8) 6.58

(d) Depth to Top of Screen 76.68 ft.

3) Depths to Centralizers 37.08, 76.01

4) Total Depth of Installed Well 87.0

5) Casing Stick Up (Standard 2.5' A.G.S.) 2.5 ft.

6) Depth to Top of Filter Pack 73.3

7) Depth to Top of Fine Sand Seal N/A

8) Depth to Top of Bentonite Seal 71.4

9) Thickness of Grout 71.4

OSR 30-3 (Rev 12-89)

FIELD GEOLOGIC LOG

PROJECT: F AREA Acid/Caustic BASIN		DATE: 1-21-92	SHEET: 1 OF 5
		DRILLING SUBCONTRACTOR: EMTC	
WELL NO.: FAC-1P	LOCATION: N77989.71 E55258.08	DRILLER: T. Hornsby	
LOGS PREPARED BY: M. Hudgins	COMPANY: AT + E	DRILLING METHOD: 7 7/8 in Rotary WASH	

RUN NUMBER	DEPTH BELOW GROUND SURFACE, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
GRAB Samples	0–3		GRAB Samples	Sand, light brown (5 YR 5/6), fine to medium, subrounded to subangular, moderately sorted.	EASY DRILLING
	3–17			Clayey Sand, light brown (5 YR 5/6), fine to coarse, subangular to angular, poorly sorted, trace micas, kaolin.	
	13–17			Clayey Sand, as above, increasing grain size and sand content with depth.	
	17–20			Sand, light brown (5 YR 5/6), fine to coarse, subrounded to subangular, well sorted, trace micas.	

OSR 30-3 (Rev 12-89)

FIELD GEOLOGIC LOG

PROJECT: F AREA ACID/CAUSTIC BASIN		DATE: 1-21-92	SHEET: 2 OF 5
		DRILLING SUBCONTRACTOR: EMTC	
WELL NO.: FAC-1P	LOCATION: N77989.71 E55258.08	DRILLER: T. Hornsby	
LOGS PREPARED BY: M. Hudgins	COMPANY:	DRILLING METHOD: 7 7/8 in Rotary Wash	

RUN NUMBER	DEPTH BELOW GROUND SURFACE, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
GRAB Samples	20		GRAB SAMPLES		
	21				
	22				
	23				
	24				
	25			Sandy Clay, dark yellowish orange (10YR 6/6) to moderate reddish brown (10R 4/6), plastic; Sand, fine to coarse with fine gravel, poorly sorted, subangular to angular, trace mafics.	hard drilling
	26				
	27				
	28				
	29			Sandy Clay, as above, moderate red (5R 4/6) to grayish red purple (5RP 5/2), mottled; Sand, as above, with few quartz gravel.	
	30				
	31				
	32				
	33				
	34				
	35				
	36				
	37				
	38				
	39				
	40				

OSR 30-3 (Rev 12-89)

FIELD GEOLOGIC LOG

PROJECT: F AREA Acid/Caustic BASIN		DATE: 1-21-92	SHEET: 3 OF 5
		DRILLING SUBCONTRACTOR: EMTC	
WELL NO.: FAC-1P	LOCATION: N77989.71 E55258.08	DRILLER: T. Hornsby	
LOGS PREPARED BY: M. Hudgins	COMPANY: AT+E	DRILLING METHOD: 7 7/8 in Rotary WASH	

RUN NUMBER	DEPTH BELOW GROUND SURFACE, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
GRAB Samples	40		GRAB Samples		
	41				
	42				
	43				
	44				
	45				
	46				
	47			Clayey Sand, moderate reddish brown, (10 R 4/6), fine to coarse, Subangular to angular, well sorted	EASIER DRILLING
	48				
	49				
	50				
	51			clayey Sand, as above, increasing clay content w/ depth, kaolin present.	
	52				
	53				
	54				
	55				
	56			clayey Sand, as above, dark yellowish orange (10 yR 6/6), increasing kaolin content.	
	57				
	58				
	59				
	60				

OSR 30-3 (Rev 12-89)

FIELD GEOLOGIC LOG

PROJECT: F AREA Acid/Caustic BASIN	DATE: 1-21-92	SHEET: 4 OF 5
	DRILLING SUBCONTRACTOR: EMTC	
WELL NO.: FAC-1P	LOCATION: N 77989.71 E 55258.08	DRILLER: T. Hornsby
LOGS PREPARED BY: M. Hudgins	COMPANY:	DRILLING METHOD: 7 7/8 in. Rotary WASH

RUN NUMBER	DEPTH BELOW GROUND SURFACE, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS/REMARKS
GRAB SAmples	60		GRAB SAmples	clayey Sand, as above.	
	61				
	62				
	63				
	64				
	65			clayey Sand, dark yellowish orange (10YR 6/6) to light brown (5YR 5/6), fine to medium, medium sorting, subangular to angular.	
	66				
	67				
	68				
	69				
	70				
	71				
	72				
	73			clayey Sand, as above, fine to coarse, poorly sorted.	
	74				
	75				
	76				
	77				
	78				
	79				
	80				

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Attachment B-2

NWP-1B Lithology

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OSR 30-3

FIELD GEOLOGIC LOG

PROJECT: Well Installation for the MWMF NW/ NE PLUMES; BGC.	REFERENCE DATUM: 269.69'	DATE: 05/23/01	SHEET: 1 OF 8
WELL NO.: NWP - 1B	SRP COORDINATES	DRILLING CONTRACTOR: PROSONIC	
LOGGED BY: NORMAN L. Bryan, SC AG #102	COMPANY: Duke E&S, Inc	DRILLER: Michael Coleman	
		DRILLING METHOD: Rotosonic - 5 3/4" dia Core	

147.0 / 138.0 = 93.87% Total Recovery

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
01	0		7.0 / 7.0	Granite Aggregate - Crusher run	
	1			SAND, Silty (~ 45%) Hauled in Fill material (Red) Silty and Clayey.	
	2		100%	SAND, Silty & organic, Black to VY dk Brown (10 YR 2/1 to 2/2) mostly organic debris. & roots	
	3			SAND, Silty / Clayey locally ~25%) lt yellowish Brown to Brownish Yellow (10 YR 6/4 to 6/8), Fine to med grained, Subrounded to Subangular, mod Sorting, dry	
	4				
	5				
	6			SAND, Silty (~ 15-20%) Reddish yellow (7.5 YR 6/8) med to fine grained, mod Sorting, Subrounded to Subangular dry	
02	7		10.0 / 10.0	Clay, Sandy & peebly (~ 40%) Dense, hard, dry, brittle - Strong Brown 7.5 YR 5/8, Med to Crs grained Sd, well to mod Sorted, dry	
	8				
	9			SAND, Silty (~ 10-20%) Pink to Reddish yellow (7.5 YR 8/4 to 7/8) Med to Crs grained, poorly Sorted Subrounded to Subangular, dry	
	10				
	1		100%		
	2				
	3				
	4				
	15				
	6				
	17				
03	8		10.0 / 9.0	SAME AS above to 24.0' - dry	
	9		90%		
	20				

OSR 30-3

FIELD GEOLOGIC LOG

PROJECT: WELL INSTALLATION for the MWMF NW/NE Plumes – BGC.	REFERENCE DATUM: 269.69'	DATE: 05/23/01	SHEET: 2 OF 8
WELL NO.: NWP – 1B	SRP COORDINATES:	DRILLING CONTRACTOR: PROSONIC	
LOGGED BY: NORMAN L. Bryan, SC PG #102	COMPANY: Duke E & S, Inc.	DRILLER: Michael Coleman	
		DRILLING METHOD: Rotosonic – 5 3/4" dia Core.	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
03	20		10.0 / 9.0	SAME AS ABOVE – dry	
	1				
	2		90%		
	3				
	4				
	25			SAND, silty (~25-35%) Red to Reddish yellow (2.5YR 5/8 to 5YR 7/8 and 6/8) fine to vy fine Mod Sorting Subrounded to Sub angular. – dry	
	6				
	22.0 7				
04	8		10.0 / 6.5	SAME AS ABOVE – dry	
	9				
	30				
	1		65%		
	2				
	3				
	4				
	35				
	6				
	32.0' 7				
05	8		10.0 / 7.5		
	9				
	40		75%	SAME AS ABOVE and becoming dominantly reddish yellow – moist to dry.	

OSR 30-3

FIELD GEOLOGIC LOG

PROJECT: WELL INSTALLATION for the MWMF NW/NE PLUMES - BGC
DATE: 05/23/01
SHEET: 3 OF 8
REFERENCE DATUM: 269.69'
DRILLING CONTRACTOR: PROSONIC
WELL NO.: NWP-1B
SRP COORDINATES:
DRILLER: Michael Coleman
LOGGED BY: Norman L. Bryan, SCPG #102
COMPANY: Duke E&S, Inc.
DRILLING METHOD: Rotosonic - 5 3/4" dia. core

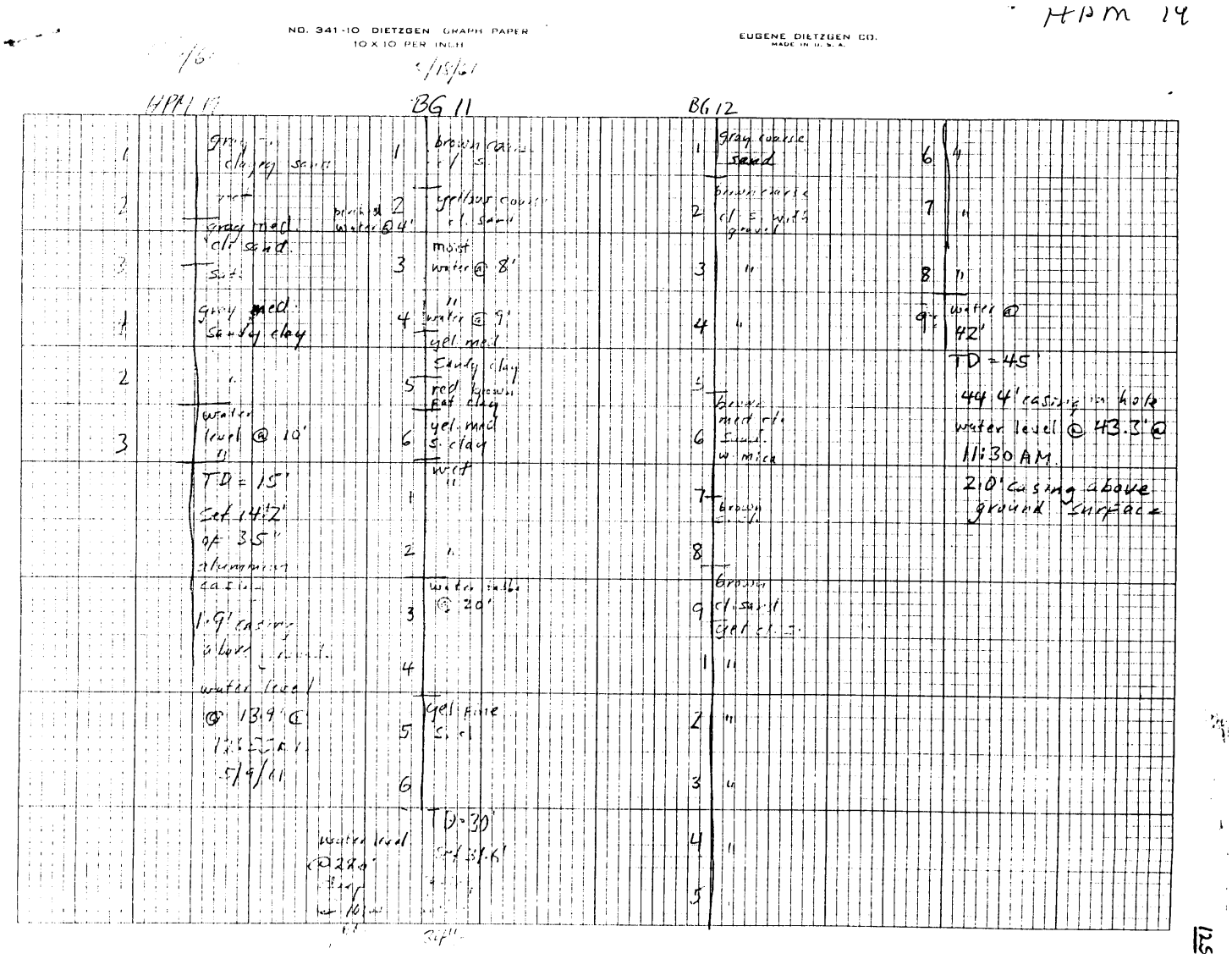
RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
	40		10.0 / 7.5	SAND, - Same as above - moist to dry.	let temporary piezometer set over night and got ~1' of water the next morning - NOT screened as a D well as per Mark Arnold
	1				
	2				
05	3		75%	~2' of moist to slightly damp. NOT saturated.	
	4				
TAN Clay @ 44.5	45			Clay, Laminated to Varved Pale yellow) to Lt Yellowish Brown (2.5Y 7/3 to 6/4) Dense, dry, hard & Stiff	
	6				
	47.0' 7		10.0 / 10.6	SAME AS ABOVE but more dominately Brownish yellow) to Yellowish Brown (10YR 6/8 to 5/8) and becoming less layered / laminated & Sandy (~10%)	
	8				
	9				
06	50				
	1		100%		
	2			Clay, Sandy & Silty (~35-40% Sd) Lt Yellowish Brown to Lt olive Brown (2.5Y 6/4 to 5/4), Softer and less dense, Sand is medium to Crs & well sorted, Subrounded to Subangular moist.	
	3				
	4				
	55			SAND, fine to medium - Olive Brown to Black Lignitic & moist.	
	6			SAND, Silty (25-35%) Pale yellow (2.5Y 7/3 to 7/4) Fine to vy fine, well Sorted Subangular to sub-rounded, moist to saturated.	
	57.0 7		10.0 / 10.0		
	8				
07	9		100%		
	60				

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Attachment B-3

HPM-19 Lithology

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NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.
HPM 14
BG 11
BG 12
gray clayey sand
gray med clayey sand
water level @ 10'
TD = 15'
Set 14.12'
of 35'
aluminum
casing
1.9' casing above ground surface
water level
@ 13.9' (
5/9/11
brown clayey sand
yellowish clay
water table @ 20'
TD=30'
water level @ 22.9'
Set 31.6'
gray coarse sand
brown clayey sand with gravel
moist
water @ 8'
water @ 9'
yel. med. sandy clay
red brown fat clay
yel. med. sandy clay
wet
brown clayey sand
yellowish clay
water @ 42'
TD = 45'
44.4' casing in hole
water level @ 43.3' @ 11:30 AM.
2.10' casing above ground surface

SAS 9:19 WEDNESDAY, JANUARY 4, 1989 52

OBS	WELL	SRPNORTH	SRPEAST	ELEVTOC	SOWELNUM	DRILDATE	DISP	CASETYPE	TOTDEPTH	CASEIDIA	GROUTYPE
2806	HPM 1	71113	62232	305.8	HPM-1	336	1	0	50	.	.
2807	HPM 2	71118	62193	303.3	HPM-2	341	1	0	50	.	.
2808	HPM 3	71118	62143	305.3	HPM-3	340	1	0	50	.	.
2809	HPM 4	71110	62043	305.3	HPM-4	349	1	0	50	.	.
2810	HPM 5	71154	61961	307.3	HPM-5	349	1	0	50	.	.
2811	HPM 6	71318	61961	306.4	HPM-6	346	1	0	50	.	.
2812	HPM 7	71395	62043	307.5	HPM-7	342	1	0	50	.	.
2813	HPM 8	71395	62160	307.3	HPM-8	346	1	0	30	.	.
2814	HPM 9	71389	62223	304.7	HPM-9	348	1	0	50	.	.
2815	HPM 10	71318	62242	306.0	HPM-10	339	1	0	50	.	.
2816	HPM 11	71249	62242	305.4	HPM-11	340	1	0	50	.	.
2817	HPM 11A	.	.	307.0	HPM-11A	621	1	0	36	.	.
2818	HPM 11B	.	.	306.4	HPM-11B	621	1	0	36	.	.
2819	HPM 11C	.	.	305.7	HPM-11C	621	1	0	45	.	.
2820	HPM 11D	.	.	302.6	HPM-11D	621	1	0	45	.	.
2821	HPM 12	71184	62242	306.2	HPM-12	340	1	0	50	.	.
2822	HPM 13	70460	62260	298.4	HPM-13	451	1	4	45	4	.
2823	HPM 14	71430	62960	299.6	HPM-14	452	1	4	45	4	.
2824	HPM 15	72160	62030	300.6	HPM-15	451	1	4	45	4	.
2825	HPM 16	72670	60890	284.2	HPM-16	468	1	4	45	4	.
2826	HPM 17	71500	60950	289.0	HPM-17	476	1	0	45	.	.
2827	HPM 18	70300	60380	291.6	HPM-18	476	1	4	31	4	.
2828	HPM 19	69270	62300	289.4	HPM-19	494	1	4	40	4	.
2829	HPM 20	70825	61835	300.8	HPM-20	472	1	4	45	.	.
2830	HPM 21	71630	62072	279.8	HPM-21	566	1	4	45	4	.
2831	HPM 22	71630	62021	282.1	HPM-22	567	1	4	40	4	.
2832	HPM 23	71630	61980	282.2	HPM-23	567	1	4	40	4	.
2833	HPM 24	71633	61956	282.1	HPM-24	567	1	4	40	4	.
2834	HPM 25	71635	62050	282.3	HPM-25	567	1	4	40	4	.
2835	HPM 26	71633	62077	282.2	HPM-26	566	1	4	40	4	.
2836	HPM 27	71617	62080	282.1	HPM-27	566	1	4	40	4	.
2837	HPM 28	71613	62051	282.0	HPM-28	566	1	4	40	4	.
2838	HPM 29	72354	61622	300.3	HPM-29	1162	1	4	50	4	.
2839	HPM 30	72354	61564	300.3	HPM-30	1162	1	4	50	4	.
2840	HPM 31	72336	61461	298.2	HPM-31	1162	1	4	50	4	.
2841	HPM 32	.	.	.	HPM-32	1552	1	6	24	.	.
2842	HPM 32A	.	.	.	HPM-32A	1162	1	0	50	.	.
2843	HPM 33	.	.	.	HPM-33	1550	1	6	44	.	.
2844	HPM 34	.	.	.	HPM-34	1551	1	6	44	.	.
2845	HPM 35	.	.	.	HPM-35	1551	1	6	44	.	.
2846	HPM 36	.	.	.	HPM-36	1551	1	6	44	.	.
2847	HPM 37	.	.	.	HPM-37	1551	1	6	45	.	.
2848	HPM 38	.	.	.	HPM-38	1552	1	6	29	.	.
2849	HPM 39	.	.	.	HPM-39	1917	1	6	9	.	.
2850	HPM 40	.	.	.	HPM-40	1552	1	6	43	.	.
2851	HPM 41	.	.	.	HPM-41	1552	1	6	44	.	.
2852	HPM 42	.	.	.	HPM-42	1550	1	6	44	.	.
2853	HPM 43	.	.	.	HPM-43	1551	1	6	44	.	.
2854	HPM 44	71520	61564	.	HPM-44	1551	1	0	35	.	.
2855	HRB 1	71700	59720	.	HRB-1	572	1	1	30	.	.
2856	HRB 2	71805	59548	.	HRB-2	572	1	1	30	.	.
2857	HRB 11	.	.	.	281-8H 11	9057	1	5	50	4	2
2858	HRB 12	.	.	.	281-8H 12	9061	1	5	50	4	2
2859	HRB 13	.	.	.	281-8H 13	9053	1	5	50	4	2

This information is from the Well File Index. 5-31-90 AK

Attachment B-4

PW-34K Lithology

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Screen Zone Elevation Work Sheet

Date: February 21, 1994

Calculations by: Cathy Rainer CA

Well I.D.: PW 34K

Screen # 1

Screen Zone Elevation (MSL):

Top -112.0

Bottom -117.0

Calculation:

* Est. Ground or Pad Elevation (msl) 263.0 ✓

** Length of Casing to Top of Screen -375.0 ✓

-112.0 ✓ Top of Screen (msl)

** Length of Screen -5.0 ✓

-117.0 ✓ Bottom of Screen (msl)

---

* Data estimated by subtracting 2.5 ft from the TOC.

** Data from SRS Production Wells (6-17-93) and/or the Well Information Sheet.

Instructions:

1. Enter the ground or pad elevation in the space provided.
2. Enter the length of casing to the top of screen in the space provided.
3. Calculate the top of screen by subtracting the length of casing from the ground elevation. Enter this number in the space provided for top of screen (msl).
4. Enter the length of screen in the space provided.
5. Calculate the bottom of screen by subtracting the length of screen from the top of screen. Enter this number in the space provided for bottom of screen (msl).
6. Enter the results of these calculations for top of screen and bottom of screen into the spaces provided under screen zone elevation.

Proofed by: CWW

Date: 2/23/94

Well 34

LAYNE ATLANTIC COMPANY

NORFOLK, VA.

K pw 34K

LOG OF WELL For Savannah River Project

Located at ... in Aiken County, State South Carolina

Date Drilling Started January 22 19 52 Date Started ... 19

Finished Drilling January 31 19 52 Finished ... 19

FORMATIONS AND DEPTH OF WELL

TOTAL DEPTH OF ALL STRATA		DEPTH OF EACH STRATUM		FORMATION FOUND AT EACH STRATUM
FT.	IN.	FT.	IN.	
10		10		Top soil
15		5		Sand and little red clay
20		5		Pink clay
25		5		Pink clay and sand
40		15		Yellow clay and sand
50		10		Sand and little yellow clay
55		5		Sand and pink clay
70		15		Sand and clay
80		10		Brown clay and little sand
90		10		Sand and little clay
105		15		Sand and gravel
110		5		Sand and clay
130		20		Sand and streaks of clay
140		10		Limerock and shell
155		15		Limerock and shell, soft drilling
160		5		Limerock and shell, hard drilling
170		10		Red clay and shell, medium drilling
190		20		Red and white clay and little sand medium drilling
200		10		Black mud and sand
220		20		Blue mud and clay, with little sand
235		15		Sand with little blue mud and clay
260		25		Fine sand
280		20		Coarse sand and little blue clay
290		10		Blue clay
325		35		Coarse sand with hard and soft streaks of blue clay
350		25		Blue clay, medium hard
370		20		Hard white clay
400		30		Red and white clay, very hard
445		45		Coarse white sand and fine gravel, very soft
462		17		Red and white clay, hard
520		58		Coarse white sand, very soft
550		30		Coarse sand and small gravel, with little wood
600		50		Coarse white sand
605		5		Blue clay and little sand
612		7		Little blue clay, red clay, and little sand

DIMENSIONS OF CASING AND SCREEN

TOTAL LENGTH OF ALL SCREENS and CASINGS		LENGTH OF EACH SIZ. OF SCREEN OR CASING		SPECIFY SCREEN OR CASING	SIZE OF SCREEN OR CASING	GAUGE OF SCREEN
FT.	IN.	FT.	IN.		IN.	
390		390		casing	18	5/16
340 feet from surface to top of 8" casing						
375		35		casing	8	5/16
380		5		slot.pipe	8	5/16
495		115		casing	8	5/16
595		100		slot.pipe	8	5/16
600		5		casing	8	5/16
355 feet from surface to top of gravel						
100 bags of cement						

WELL DATA:

Preliminary Test

Date Tested 2-6- 1952 Static Level 80'

Production 575 GPM Pumping Level 95'

Permanent Test

Date Tested 19 Static Level

Production GPM Active St. Level

Drawdown Pumping Level

Remarks:

PUMP DATA:

Shop No. Type Lubr.

Type Head Size Suction

Depth Setting (BP to MB)

Size Column Length Suction

Type Bowl Length Air Line

No. Stages Discharge-

Cap'y and Head Pressure

MOTOR DATA:

Horsepower Voltage

RPM Phase

Type Cycles

Make Frame No.

Attachment B-5

LSW-05C Lithology

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OSR 30-11# (Rev 3-9-99)
Page 1 of 4

Monitoring Well Installation Report

Well Number (AAA,NNN,AA): LSW 05

General

Project Name: L-Area Southern Groundwater Characterization

Project Manager (Last Name, First Initial): Ron Falise
Department: ER

Installation Purpose (Monitoring, Piezometer, etc.): Groundwater Monitoring
County:
Location Description:

SRS North Grid Coordinate	SRS East Grid Coordinate	Latitude (deg/min/sec)	Longitude (deg/min/sec)	Ground Elevation	Top Casing Elevation	Liquid Level Pipe Elevation
~~N48311.446~~ 48311.49	~~E51156.001~~ 51155.2	33-12-57.9	81-37-33.49	~~249.025~~ 249.69		251.62

Drilling and Sampling

Drilling Start Date	Drilling Completion Date	Total Drilled Depth	Initial Static Water Level/Date	Total Borehole Deviation (Angle/Direction)
9/20/01	9/27/01	167.0'		

Drilling/Sampling Method	Top Depth	Bottom Depth	Diameter	*	Drilling/Sampling Method	Top Depth	Bottom Depth	Diameter	*
Rotosonic Core	0	167.0	6"						
Rotosonic	0	159.0	8"						

Drilling Company	Driller (Last Name, First Initial	Oversight Company	Oversight (Last Name, First Initial
Prosonic	Michael Coleman	SAIC	Jim Furlow

Drilling and Sampling Comments (Drilling Muds Used, Source of Water, Lost Circulation Zones, etc.)

Geophysical Logging

Date Logged	Logging Top Depth	Logging Bottom Depth	Logging Subcontractor	Logging Truck Operator
9/26/01	0	167.0'	Prosonic	Johnnie Rinder

Geophysical Logs

☐ Caliper ☐ Gamma ☑ Natural Gamma ☐ Neutron Density ☐ Resistivity ☐ Single Pt Resistivity ☐ L&S Normal Resistivity ☐ Spontaneous Potential

Other Geophysical Logs (List)

Backfill Top Depth	Backfill Bottom Depth	Backfill Material (Include Type, Quantity and Units)
159.0'	167.0'	2 50-lb. bags of Baroid Hole Plug

Elevations measured from height above MSL. Depths measured from ground surface to nearest 0.1 ft. *Enter an "X" if cuttings were taken.

OSR 30-3

FIELD GEOLOGIC LOG

PROJECT: L-Area Southern Groundwater Characterization		DATE: 9/20/01	SHEET: 1 OF
	REFERENCE DATUM	DRILLING CONTRACTOR: Prosonic	
WELL NO.: LSW-05	SRP COORDINATES	DRILLER: Michael Coleman	
LOGGED BY: Jim Furlow	COMPANY: SAIC	DRILLING METHOD: Rotosonic Coring	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
1	0–7		100	0'-7' Clayey Sand: moderate reddish brown (10R4/6) to yellowish gray (5Y8/1), fine to medium grained, some coarse grains, subrounded to subangular, hard to stiff, low plasticity, dry, laminated to mottled.	
2	7–17		100	7'-17' Silty Sand to Clayey Sand: moderate reddish brown (10R4/6) to yellowish gray (5Y8/1), fine grained, subangular, very silty, slightly clayey 7'-15.5', very clayey, slightly silty 15.5'-17.0', soft, low plasticity, damp.	
3	17–20		50	17'-22' Sandy Clay: yellowish gray (5Y8/1) to moderate red (5R4/6), very fine grained, soft, medium plasticity, mottled to laminated, damp.	

OSR 30-3

FIELD GEOLOGIC LOG

PROJECT: L-Area Southern Groundwater Characterization	REFERENCE DATUM:	DATE: 9/20/01	SHEET: 2 OF
WELL NO.: LSW-05	SRP COORDINATES:	DRILLING CONTRACTOR: Prosonic	
LOGGED BY: Jim Furlow	COMPANY: SAIC	DRILLER: Michael Coleman	
		DRILLING METHOD: Rotosonic Core	

RUN NUMBER	DEPTH, FEET	LITHOLOGY	PERCENT RECOVERY	SAMPLE DESCRIPTION	DRILLING COMMENTS
3	20–27		50	No Recovery 22'–27'	
4	27–37		100	27'–37' Clayey Sand to Silty Sand: yellowish gray (5Y 8/1) to moderate reddish orange (10R 6/6) to grayish orange pink (10R 8/2), fine grained, subangular, soft, low plasticity, wet. Mostly clayey 27'–34', then mostly silty, slightly clayey 34'–37', mottled to laminated.	
5	37–40		100		

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APPENDIX C

HUMAN HEALTH RISK ASSESSMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

~	approximately
AAP	A-Area Ash Pile (788-A)
ac	acre(s)
ACPRB	A-Area Coal Pile Runoff Basin (788-3A)
BRA	baseline risk assessment
CMS	corrective measures study
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
EA	Early Action
EPC	exposure point concentration
FAL	F-Area Ash Basin (288-F)
FS	feasibility study
ft	feet
ha	hectare(s)
HAB	H-Area Ash Basin (288-H)
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
KAB	K-Area Ash Basin (188-K)
LAB	L-Area Ash Basin (188-L)
m	meter
m^3	cubic meters
OU	operable unit
pCi/g	picocuries per gram
PRG	preliminary remediation goal
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RI	remedial investigation
RME	reasonable maximum exposure
RSL	regional screening level
SCDES[1]	South Carolina Department of Environmental Services
SRS	Savannah River Site
UCL	upper confidence limit
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
yd^3	cubic yard

[1] SCDES was known as the South Carolina Department of Health and Environmental Control prior to July 1, 2024.

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C-1. INTRODUCTION

The human health risk assessment (HHRA) in support of the Focused Early Action (EA) Corrective Measures Study (CMS)/Feasibility Study (FS) for the remaining coal ash and coal fines Operable Units (OUs): A-Area Ash Pile (788-A) (AAP) and A-Area Coal Pile Runoff Basin (788-3A) (ACPRB) OU, F-Area Ash Landfill (288-F) (FAL) OU, H-Area Ash Basin (288-H) (HAB) OU, K-Area Ash Basin (188-K) (KAB) OU, and L-Area Ash Basin (188-L) (LAB) OU is presented in this appendix. The evaluation contained herein assesses the risks of contamination to human receptors to identify the problems warranting action from a human health standpoint to support subsequent remediation as deemed necessary. The human health risk assessment for the remaining coal ash and coal fines OUs is conducted per the approved protocols outlined in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2023b).

In 2022, the United States Department of Energy (USDOE) proposed a wholistic remedial approach to address several of the remaining coal ash and coal fines OUs at the Savannah River Site (SRS), including future beneficial reuse (BR) of the ash material as a fill material or concrete additive rather than a waste material that requires excavation and disposal or containment by an engineered cover system (SRNS 2022). The remaining coal ash and coal fines OUs consists of five OUs as listed in Appendix C of the Federal Facilities Agreement for SRS (FFA 1993). The OUs will receive final disposition path as a remedial action under the SRS Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response Compensation and Liability Act program.

In general, the remaining coal ash and coal fines OUs are located near or within the perimeter of industrial areas. The ACPRB is located within an area designated for industrial use. The AAP, FAL OU, HAB OU, and KAB OU are partially located within an area designated for industrial use based on Facility Area boundaries. The LAB OU is not located in an industrial use area as it is located outside of the facility boundary. No current or future development of the remaining coal ash and coal fines OUs is planned. Nevertheless, to support the risk management decision-making, both the residential (unrestricted) and industrial land use scenarios are evaluated.

The HHRA is conducted and presented for each OU for the evaluation of risk to human health receptors. Exposure is assessed by screening environmental data from the OUs' Remedial Investigation (RI)/Baseline Risk Assessment (BRA) database and evaluating the potential for exposure. The media in question at remaining coal ash and coal fines OUs consists of ash with minor amounts of soil. For this reason, the media type that is evaluated in this section will be referred to as ash/soil. For the purposes of this risk assessment the media is evaluated against soil thresholds to determine the risk to the identified receptors.

C-1.1 Background

As discussed, the remaining coal ash and coal fines OUs consist of five OUs as discussed in the following sections. A detailed description of each OU is provided in Chapters 1 and 2.

C-1.1.1 A-Area Ash Pile (778-A) and A-Area Coal Pile Runoff Basin (788-3A) Operable Unit

The AAP contains bottom ash and fly ash received from the A-Area Boiler House (784-A) between 1952 and 1978. During operation of the AAP, the pile was graded, the top leveled, and the north side (stream side) benched. The AAP encompasses 0.65 hectares (ha) (1.60 acres [ac]). The ash within the AAP extends northward towards the edge of an unnamed tributary to Tims Branch. The total area of ash, including ash outside the boundary, is ~1.03 ha (2.55 ac). The total volume of ash is ~53,519 m^3 (70,000 yd^3). The depth of ash is variable with the average depth of ~5.0 m (17.0 ft). Figure C-1 shows the boundary of the AAP and the extent of ash.

The ACPRB was constructed in 1978 and operated until closure of the A-Area Boiler House (784-A) in 2008. Runoff from the coal storage pile was collected/transported in ditches and underground pipes that discharged to the ACPRB. The ACPRB covers approximately (~) 1.06 ha (2.62 ac). The approximate total volume of coal fines is 7,645 m^3 (10,000 yd^3). The average depth of coal fines within the ACPRB is ~0.7 m (2.4 ft). Figure C-2 shows the boundary of the ACPRB.

C-1.1.2 F-Area Ash Landfill (288-F) Operable Unit

The FAL OU is an active Class II Landfill (South Carolina Department of Environmental Services [SCDES[2]] Solid Waste Landfill Permit #025800-1601). The FAL OU consists of the active landfill and the area outside the landfill boundary where ash deposits are known to exist. The FAL OU became operational in 1954 and received ash from the A-, F-, and H-Area powerhouses during its operational history. The interior of the landfill is ~2.84 ha (7.01 ac). As of August 2023, the volume of ash within the FAL OU was calculated to be ~151,458 m^3 (198,099 yd^3). Additional ash outside of the landfill is estimated to have an area of 4.64 ha (11.47 ac) and a volume of 11,744 m^3 (15,360 yd^3). The total area of ash is ~7.48 ha (18.48 ac) and the total volume of ash at the FAL OU is ~163,201 m^3 (213,459 yd^3). The depth of ash is variable with an average depth of ~9.8 m (32.0 ft). Figure C-3 shows the OU boundary of the FAL OU and the extent of ash.

C-1.1.3 H-Area Ash Basin (288-H) Operable Unit

The HAB OU received ash via sluice of wet ash slurry from the H-Area Powerhouse (284-H). The coal-fired powerhouse operated from 1950 to 1990. The HAB OU includes wet ash/soils within and beyond the boundary of the OU. The wet ash/soil coincide with a Carolina bay that is partially located within the southeastern boundary of the HAB OU. In 1993 to 1994, ~ 76,455 m^3 (100,000 yd^3) of ash was removed from the basin and transported to the FAL OU and F-Area Ash Basin (288-1F). The area of the HAB OU is ~5.29 ha (13.06 ac). The volume of ash within the boundary is ~84,944 m^3 (111,103 yd^3). Additional ash outside of the basin boundary is estimated to have an area of ~7.45 ha (18.40 ac) and a volume of 113,161 m^3 (148,009 yd^3). The total area of ash within and outside of the basin boundary is ~12.73 ha (31.46 ac). The total volume of ash inside and outside the basin boundary is ~198,105 m^3 (259,112 yd^3). The depth of ash is variable with an average depth of ~3.6 m (12.0 ft). Figure C-4 shows the OU boundary of the HAB OU and the extent of ash.

[2] SCDES was known as the South Carolina Department of Health and Environmental Control prior to July 1, 2024.

C-1.1.4 K-Area Ash Basin (188-K) Operable Unit

The KAB OU received ash from the K-Area Powerhouse (184-K) via wet sluice. The coal-fired powerhouse operated from 1951 to 1990. The area of the basin is ~ 4.52 ha (11.16 ac). The volume of ash within the boundary is ~194,627 m^3 (254,563 yd^3). Additional ash outside of the basin boundary is estimated to be 1.54 ha (3.81 ac) with a volume of 13,734 m^3 (17,964 yd^3). The total area of ash inside and outside the basin is ~6.06 ha (14.97 ac). The total volume of ash inside and outside the basin boundary is ~208,362 m^3 (272,527 yd^3). The depth of ash is variable with an average depth of ~4.5 m (15.0 ft). Figure C-5 shows the OU boundary for the KAB OU and the extent of ash.

C-1.1.5 L-Area Ash Basin (188-L) Operable Unit

The LAB OU received ash from the L-Area Powerhouse (184-L) via wet sluice. The coal-fired powerhouse operated from 1951 to 1968. The interior area of the basin is ~ 7.13 ha (17.61 ac), with a volume of ash within the boundary of ~233,189 m^3 (305,000 yd^3). Additional ash outside of the basin boundary is estimated to have an area of 0.68 ha (1.67 ac) and a volume of ~13,781 m^3 (18,026 yd^3). The total area of ash within and outside of the basin boundary is ~7.80 ha (19.28 ac). The total volume of ash inside and outside the basin boundary is ~246,971 m^3 (323,026 yd^3). The depth of ash is variable with an average depth of ~3.3 m (11.0 ft). Figure C-6 shows the OU boundary for the LAB OU and the extent of ash.

C-1.2 Data

Characterization activities for the remaining coal ash and coal fines OUs are described in detail in Chapter 3. The five OUs were placed in two groups based on unit type, quantity of available data, and level of data assessment as described below.

AAP and ACPRB OU

Data from the AAP and ACPRB OU are reported in the approved *RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-*

Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit (U) (SRNS 2012). The HHRA evaluation of the AAP and ACPRB OU is complete, and the results of the previous BRA are included as part of this HHRA in support of the Focused EA CMS/FS process.

FAL, HAB, KAB, and LAB OUs

Due to the consistency with other ash waste unit risk evaluations that have been performed in the past, including OUs that have gone through a formal BRA process, such as the AAP and ACPRB OU (Table C-1), the U. S. Environmental Protection Agency (USEPA), SCDES, and USDOE agreed at the Focused EA CMS/FS Scoping Meeting in November 2023 (SRNS 2023a), that the data from the HAB, KAB, and LAB OUs would be combined into one dataset for data processing in accordance with the approved protocols in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2023b).

The Core Team, USEPA, SCDES, and USDOE, also agreed during the Focused EA CMS/FS Scoping Meeting in November 2023 that the results of the risk assessment for the HAB, KAB, and LAB OUs would apply to the FAL OU (SRNS 2023a).

The data used in the HHRA for the FAL, HAB, KAB, and LAB OU are presented in Appendix A. The ProUCL (USEPA 2022) software package was used to calculate the 95% upper confidence limit (UCL) on the arithmetic means that are presented in Appendix A. The data distribution and recommended 95% UCL as determined by ProUCL for each constituent are presented as footnotes to the tables in Appendix A. Non-detected constituent concentrations were processed in accordance with the ProUCL User's Guide.

Groundwater media is not part of the BR evaluation for the remaining coal ash and coal fines OUs.

C-1.3 Receptors

The purpose of the HHRA is to evaluate the potential for adverse effects associated with exposure to constituents present in the remaining coal ash and coal fines OUs. The assessment estimates the risk potential in the absence of any remedial action and provides a basis for determining whether

remedial actions are necessary to reduce or eliminate risks to human health. A streamlined approach that considers both standardized and site-specific receptor scenarios/exposure assumptions has been used for this evaluation.

The receptors evaluated include future resident and future industrial worker. A description of each is presented below.

The *future resident* receptor scenario evaluates long-term risks to individuals assumed to have unrestricted use of the area. This scenario considers residents (adults and children) that hypothetically live on-unit and are exposed chronically, both indoors and outdoors, to the contaminants present. The standard exposure assumptions are 26 years, 350 days per year, and 24 hours per day. Exposure routes associated with soil include inhalation of particulates and vapors, external exposure to radiation, dermal absorption, and incidental ingestion.

The *future industrial worker* scenario is a standard USEPA exposure scenario, which addresses long-term risks to workers who are exposed to the on-unit contaminants within an industrial setting. The standard exposure assumptions are 25 years, 250 days per year, and 8 hours per day. This receptor is referred to as "composite worker" by USEPA and is analogous to the term "industrial worker" used herein. The future industrial worker scenario considers an adult who hypothetically works on-unit in an outdoor setting for the majority of time. Exposure routes include inhalation, external exposure to radiation, dermal absorption, and incidental ingestion of soil.

C-1.4 Sources of Risk-Based Threshold Values

The USEPA publishes regional screening levels (RSLs) for nonradiological constituents and preliminary remediation goals (PRGs) for radiological constituents that are risk-based concentrations (or activity concentrations) that can be used to evaluate potentially contaminated waste sites. Both RSLs and PRGs combine current USEPA toxicity values with standard exposure factors that represent reasonable maximum exposure (RME) conditions to estimate contaminant concentrations in exposure media that the agency considers protective of humans over a lifetime. The concentrations are based on direct exposure pathways for which generally accepted methods, models, and assumptions have been developed for specific land use conditions.

The *USEPA Regional Screening Levels (RSLs)* website (USEPA 2024a) is the source of risk-based threshold values for nonradiological constituents used in this evaluation. The website was accessed in June 2024. The default resident and industrial worker RSLs are provided in Attachment C-1.

The *USEPA Superfund Radionuclide Preliminary Remediation Goals (PRGs) for Superfund* website (USEPA 2024b) is the source of the radionuclide threshold values used in this evaluation. The website was accessed in June 2024. The PRGs for a residential scenario were obtained by using the website calculator function to derive site-specific peak PRGs. These site-specific PRGs are calculated by eliminating the fruit and vegetable consumption pathways and using all other default parameters. The site-specific residential PRGs are provided in Attachment C-2. The peak PRGs for the industrial worker assume all default exposure parameters and are provided in Attachment C-3.

C-2. HUMAN HEALTH RISK ASSESSMENT PROCESS

The basis for this evaluation is to refine the preliminary conceptual site models (CSMs). The CSMs are graphical representations of the subunit sources of contamination and potential impacts to human health and the environment. The CSMs establish the focus for the risk assessment, identifying the sources of contamination, the release mechanisms into exposure media, the exposure routes associated with media, and the potential receptors evaluated in the risk assessment. As depicted in Figures 10 through 15, the CSMs include the following elements:

- Primary sources of contamination
- Primary environmental release mechanisms
- Secondary sources of contamination
- Secondary release mechanisms
- Exposure media
- Exposure routes
- Human receptors

C-2.1 Ash/Soil Media

The primary dataset used for the human health screening and risk/hazard calculations is the 0 to 0.3 m (0 to 1 ft) depth sample interval. Concentrations of detected constituents in the 0 to 0.3 m

(0 to 1 ft) depth interval include both the maximum and the 95% UCL on the mean concentration for screening and risk/hazard calculations, respectively.

A summary of the processes undertaken to evaluate human health associated with the various exposure media is described below.

C-2.1.1 Constituents of Potential Concern

The process used to identify constituents of potential concern (COPCs) in each of the remaining coal ash and coal fines OUs is described below. Maximum detected concentrations of nonradiological constituents were compared to the hazard quotient (HQ) = 0.1 residential soil RSLs for noncarcinogens; for carcinogens, the residential soil RSL is used as a screening threshold. If a substance causes both cancer and noncancer (systemic) effects, the more stringent criteria shall take precedence. Maximum detected activity concentrations of radiological constituents were compared to residential soil PRGs. For naturally occurring, non-anthropogenic constituents, maximum soil concentrations from the 0 to 0.3 m (0 to 1 ft) sampling interval were also compared to two times the SRS average background concentrations (WSRC 2006). Constituents exceeding both the RSL/PRG residential screening thresholds and the SRS background values are identified as COPCs. COPCs are carried forward to the risk/hazard calculation (Section C-2.1.2). Appendix A presents the ash/soil dataset for the OUs.

Constituents recognized as essential human nutrients (i.e., calcium, magnesium, potassium, and sodium) are not subject to further evaluation since these constituents are deemed necessary for health and consumed in normal diets.

Section C-2.2 presents the results of the COPC screening step.

C-2.1.2 Risk/Hazard Calculation

The next step in the HHRA for the remaining coal ash and coal fines OUs is to calculate risk or hazard for the resident and industrial worker. Risk and hazard estimate calculations are based on a RME exposure point concentration (EPC), which is the lesser of the maximum detected

concentration and the 95% UCL on the mean concentration. Appendix A tables provide the EPCs for each of the COPCs.

For carcinogens, the risk estimates for constituents are calculated using the following equation:

$$risk\ estimate = \left(\frac{[EPC]}{[RSL\ or\ PRG]}\right) \times 1E\text{-}06$$

The risk estimates by constituent grouping (i.e., inorganic, organic, and radionuclide) are then summed to provide the total risk by grouping. The total media risk is the sum of the total groupings. Constituents with an individual cancer risk greater than 1E-06 are identified as COCs and are further evaluated in the refinement of COCs step (Section C-2.2).

For noncarcinogens, hazard quotients (or HQs) are calculated individually for each nonradiological constituent using the following equation:

$$hazard\ quotient\ (HQ) = \frac{[EPC]}{[RSL]}$$

Individual constituent HQs are summed to provide the total hazard index (HI). If the total HI is less than 1, then no COCs are identified. If the total HI is greater than 1, then the constituents are segregated based on relevant target organ or system toxicity, and the grouped constituent HQs are summed. Constituents are identified as COCs if the constituent organ/system HQ is greater than 0.1 and the total organ HI is greater than 1. Constituents identified as COCs are further evaluated in the refinement of COCs step (Section C-2.2).

C-2.2 Refinement of Constituents of Concern/Results

To identify human health refined COCs (RCOCs) by OU for the remaining coal ash and coal fines OUs, an uncertainty analysis is performed for each individual COC. This includes an interpretive discussion of the applicable uncertainty factors (lines of evidence) and a recommendation of whether the constituent should or should not be carried forward for further remedial evaluation. The major categories of uncertainty used in this evaluation and the major emphasis include:

- Unit related uncertainty, which includes uncertainties related to the nature and extent of contamination, consistency with history of use, and presence in background;
- Data quality uncertainty, which includes uncertainties related to data quality and physical characteristics; and
- Risk assessment uncertainty, which includes uncertainties related to toxicity data and changes in constituent concentrations due to radioactive decay.

For the uncertainty evaluation, subunit concentrations are compared to SRS all-depths background concentrations (WSRC 2006) as one line of evidence to assist in the identification of RCOCs.

Note that for the background comparisons involving a particular decay chain, activities of the parent and its daughter products are considered. For example, the thorium series (thorium-232) evaluation includes not only the measured concentration of thorium-232, specifically, but also includes any analytical results from its daughter products (e.g., radium-228, actinium-228, thorium-228, radium-224, lead-212, bismuth-212, and thallium-208) since these isotopes are assumed to be in secular equilibrium. This same approach was applied for the uranium-238 decay series, including its daughter products (e.g., uranium-234, thorium-230, radium-226, lead-214, and bismuth-214). Therefore, background comparisons for the thorium-232 decay series and the uranium-238 decay series includes consideration of the range of concentrations for the entire decay chain (i.e., includes daughter products).

C-2.2.1 AAP and ACPRB OU

C-2.2.1.1 Ash/Soil Media

An *RFI/RI Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measure Study/Feasibility Study (CMS/FS) Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit* (SRNS 2012) has been performed for the AAP and ACPRB OU. The complete HHRA is provided in Appendix E of the referenced report. The conclusions of the HHRA are outlined below.

C-2.2.1.2 HHRA Conclusion for AAP

Ash/Soil media RCOCs:

Resident scenario: arsenic, potassium-40, radium-226, uranium-238.

Industrial Worker scenario: arsenic, potassium-40, radium-226, uranium-238.

Although radium-226 was identified as an individual RCOC in the previous HHRA, risk will be managed under the cleanup level established for the entire uranium-238 decay series.

C-2.2.1.3 HHRA Conclusion for ACPRB

Ash/Soil media RCOCs:

Resident scenario: arsenic.

Industrial Worker scenario: arsenic.

C-2.2.2 FAL, HAB, KAB, and LAB OUs

C-2.2.2.1 Ash/Soil Media

Table C-2 presents the results of ash/soil screening for the HAB, KAB and LAB OUs. As described above, the risk levels/conclusions of the HAB, KAB and LAB OU evaluation will also be applied to the FAL OU. Human health COPCs for ash/soil include aluminum, arsenic, chromium, cobalt, iron, manganese, vanadium, potassium-40, thorium-232, uranium-235 and uranium-238. These constituents had maximum detected concentrations that exceeded human health (residential) risk-based screening levels and exceeded two times SRS mean background concentrations.

Table C-3 presents the total HI (1.99E+00) and total media risk (9.78E-04) for the resident exposure scenario and the associated COCs: arsenic, chromium, potassium-40, thorium-232, uranium-235 and uranium-238.

Table C-4 presents the total HI (1.40E-01) and total media risk (5.74E-04) for the industrial worker exposure scenario and the associated COCs: arsenic, chromium, potassium-40, thorium-232, uranium-235 and uranium-238.

The refinement/uncertainty evaluation is presented for each of these COCs.

Arsenic is identified as a COC for the resident (risk = 5.56E-05, HQ = 1.08) and the industrial worker (risk = 1.25E-05) scenarios. It was detected in 9/9 samples, with all results being quantifiable values. Concentrations range from 12.1 mg/kg to 76.5 mg/kg, with a mean concentration of 25.19 mg/kg. The EPC used in the risk calculations was 37.61 mg/kg.

Arsenic is a naturally occurring constituent that is common in the environment. Arsenic is widely distributed in the earth's crust, being present in soil and minerals. The maximum detected concentration in the SRS soil background dataset is 22.9 mg/kg. Ash/soil concentrations from this subunit are above the range of concentrations found in background soil at SRS. Arsenic, naturally present in coal, may be concentrated in coal ash because it is not lost during combustion; thus, it is expected to be present at these OUs due to the ash material that has been deposited.

Arsenic is recommended for further remedial evaluation as a human health RCOC in ash/soil for any of the receptor scenarios based on the following lines of evidence:

- The residential and industrial risk is >1E-06,
- Unit concentrations are above the background soil concentration range,
- Its presence is consistent with the historical use of the unit.

Chromium is identified as a COC for residential (risk = 4.25E-05) and the industrial worker (risk = 2.02E-06) scenarios. Chromium was detected in 9/9 samples, with all results being quantifiable values. Concentrations range from 5.75 mg/kg to 18.7 mg/kg, with a mean concentration of 9.96 mg/kg. The EPC used in the risk calculations was 12.79 mg/kg.

The maximum detected concentration in the SRS soil background dataset is 54.3 mg/kg. Ash/soil concentrations from this subunit are within the range of concentrations found in background soil at SRS.

Chromium occurs in the environment primarily in two valence states, trivalent chromium and hexavalent chromium. Trivalent chromium is much less toxic than hexavalent chromium. The trivalent form is considered noncancerous, whereas the hexavalent form is considered cancerous. Chromium compounds, in the trivalent chromium or hexavalent chromium forms, are used for chrome plating, the manufacture of dyes and pigments, and leather and wood preservation.

Hexavalent chromium is not a naturally occurring constituent that is common in the environment. Hexavalent chromium is an environmental concern where burning was used. Trivalent chromium is converted to hexavalent chromium during the burning process. Hexavalent chromium is more toxic and mobile in the environment as compared to trivalent chromium. The USEPA recommends that valence-specific state data for chromium be collected when chromium is likely to be an important contaminant at the site. A hexavalent and total chromium analysis was evaluated for this assessment. All hexavalent chromium analyses were non-detect.

The risk estimate used the hexavalent chromium RSL (residential RSL = 0.3 mg/kg, industrial worker RSL = 6.33 mg/kg) to perform the data screening as a total chromium RSL is not available. This overly conservative approach tends to bias the calculation high. Based on unit history, it is likely the trivalent form of chromium is most prevalent at the site. The RSLs for trivalent chromium are 85,000 mg/kg for the residential exposure scenario, and 360,000 mg/kg for the industrial worker exposure scenario. The maximum detected concentration at the waste unit is much less than these concentrations, and a calculation using the 95% UCL would yield a HQ = 1.50E-04 for the residential scenario and a HQ = 3.55E-05 for the industrial worker scenario.

The USEPA published a total chromium RSL of 280 mg/kg for the residential scenario and 1,400 mg/kg for the industrial worker scenario in the April 2009 version of the tables. If these values were used in the risk calculation, the risk for the resident = 4.57E-08 and the risk for the industrial worker = 9.14E-09.

Chromium is not recommended for further remedial evaluation as a human health RCOC in the ash/soil for either receptor scenario based on the following lines-of-evidence:

- It is a naturally occurring constituent that is common in SRS background soils.
- All sample results are within the SRS background soil concentration range for total chromium.
- Risk estimate is biased high because the most conservative RSL (hexavalent chromium) was used, but this form is not expected to be present based on unit history and non-detect hexavalent chromium sample results.
- Using the trivalent chromium RSL, the revised HQ = 1.50E-04 for the resident and 3.55E-05 for the industrial worker, which are less than the threshold value of HQ =1.
- Using the total chromium RSL that was available in 2009, the revised risk estimate = 4.57E-08 for the resident and 9.14E-09 for the industrial worker, which are less than the threshold value of 1E-06.

Potassium-40 is a COC for the resident (risk = 7.75E-05) and the industrial worker (risk = 5.10E-05) scenarios. Potassium-40 was detected in 9/9 samples, with all results being quantifiable values. Concentrations range from 2.3 pCi/g to 12.5 pCi/g, with a mean concentration of 9.2 pCi/g. The EPC used in the risk calculations was 11.16 pCi/g.

Potassium-40 is a naturally occurring constituent that is common in the environment. The SRS background maximum activity concentration is 8.53 pCi/g. Ash/soil concentrations from this subunit are above the range of concentrations found in background soil at SRS.

Potassium-40, naturally present in coal, is concentrated in coal ash because it is not lost during combustion; thus, it is expected in these OUs due to the ash material deposited.

Potassium-40 is recommended for further remedial evaluation as a human health RCOC in ash/soil for the any of the receptor scenarios based on the following lines of evidence.

- The residential and industrial risk is >1E-06,
- Unit concentrations are above the background soil concentration range,
- Its presence is consistent with the historical use of the unit.

Thorium-232 is a COC for the resident (risk = 3.47E-04) and the industrial worker (risk = 2.24E-04) scenarios. The thorium series (thorium-232) evaluation includes not only the measured activity concentration of thorium-232 specifically, but it also considers any analytical results from its daughter products (e.g., radium-228, actinium-228, thorium-228, lead-212, bismuth-212, and thallium-208) since these isotopes are assumed to be present in secular equilibrium. The risk calculations were performed using the highest EPC (3.42 pCi/g for bismuth-212) of the entire series. The daughter products are not evaluated separately since they are considered in the thorium-232 peak PRG.

Background comparisons for the thorium-232 series include consideration of the range of activity concentrations for the entire decay chain (i.e., includes daughter products). The SRS soil background maximum detected activity concentration is 6.75 pCi/g, based on the radium-228 result (WSRC 2006). Ash/soil concentrations from this subunit are below the range of concentrations found in background soil at SRS.

Thorium-232, naturally present in coal, is concentrated in coal ash because it is not lost during combustion; thus, it is expected in these OUs due to the ash material deposited.

Thorium-232 is recommended for further remedial evaluation as human health RCOC in ash/soil for any of the receptor scenarios based on the following lines of evidence:

- The residential and industrial risk is >1E-06,
- Its presence is consistent with the historical use of the unit.

Uranium-235 is a COC for the resident (risk = 1.22E-05) and the industrial worker (risk = 7.67E-06) scenarios. Uranium-235 was detected as an estimated value (i.e., J-qualified) in 1/9 samples with an activity concentration of 0.561 pCi/g.

Uranium is a naturally occurring constituent that is common in the environment. The maximum detected activity concentration in the SRS soil background data for uranium-235 is 0.17 pCi/g. The only detected activity concentration is above the SRS soil background activity concentration range, however, it was qualified as an estimated quantity.

Uranium-235 is not recommended for further remedial evaluation as a human health RCOC in ash/soil for any receptor scenario based on the following lines of evidence:

- It was only detected in 1/9 samples and qualified as an estimated quantity,
- It is a naturally occurring constituent that is common in SRS background soils.

Uranium-238 is a COC for the resident (risk = 4.43E-04) and the industrial worker (risk = 2.77E-04) scenarios. The uranium Series (uranium-238) evaluation includes not only the measured activity concentration of uranium-238, but also considers any analytical results from its daughter products (e.g., uranium-234, thorium-230, radium-226, lead-214, and bismuth-214) since these isotopes are assumed to be in secular equilibrium. The risk calculations were performed using the highest EPC (5.54 pCi/g for radium-226) for the entire series. The daughter products are not evaluated separately since they are considered in the uranium-238 peak PRG.

Uranium is a naturally occurring constituent that is common in the environment. The maximum detected activity concentration for the uranium-238 decay chain in the SRS soil background data set is 2.78 pCi/g (for thorium-230). Ash/soil activity concentrations from this subunit are above the activity range found in background soil at SRS.

Uranium-238, naturally present in coal, is concentrated in coal ash because it is not lost during combustion; thus, it is expected in these OUs due to the ash material deposited.

Uranium-238 is recommended for further remedial evaluation as a human health RCOC in ash/soil for any receptor scenario based on the following lines of evidence:

- The residential and industrial risk is >1E-06,
- Unit activity concentrations are above the SRS soil background activity concentration range,

- Its presence is consistent with the historical use of the unit.

C-2.2.2.2 HHRA Conclusion for FAL, HAB, KAB, LAB OUs

Ash/Soil media RCOCs:

Resident scenario: arsenic, potassium-40, thorium-232, uranium-238.

Industrial Worker scenario: arsenic, potassium-40, thorium-232, uranium-238.

C-3. SUMMARY/CONCLUSION OF THE HUMAN HEALTH RISK ASSESSMENT

The table presented below shows the overall summary of the HHRA by subunit. Based on the results of this assessment the refined CSMs are presented in Figures 15 through 21.

Summary of the remaining coal ash and coal fines OUs Human Health Risk Assessment

OU	Human Health Residential RCOCs	Human Health Industrial Worker RCOCs
AAP (778-A)	Ash/Soil (0 to 0.3 m [0 to 1 ft]) Arsenic, (risk = 5.4E-05) Potassium-40, (risk = 1.3E-04) Radium-226[1], (risk = 1.8E-04) Uranium-238 (risk = 2.8E-06) TCR = 3.7E-04	Ash/Soil (0 to 0.3 m [0 to 1 ft]) Arsenic, (risk = 1.3E-05) Potassium-40, (risk = 7.3E-04) Radium-226[1], (risk = 1.0E-04) Uranium-238 (risk = 1.4E-06) TCR = 1.9E-04
ACPRB (788-3A)	Ash/Soil (0 to 0.3 m [0 to 1 ft]) Arsenic, (risk = 9.4E-05)	Ash/Soil (0 to 0.3 m [0 to 1 ft]) Arsenic, (risk = 2.3E-05)
FAL (288-F), HAB (288-H), KAB (188-K), LAB (188-L)	Ash/Soil (0 to 0.3 m [0 to 1 ft]) Arsenic, (risk = 5.6E-05; HQ = 1.1) Potassium-40, (risk = 7.8E-05) Thorium-232, (risk = 3.5E-04) Uranium-238 (risk = 4.4E-04) TCR = 9.8E-04; HI = 2.0	Ash/Soil (0 to 0.3 m [0 to 1 ft]) Arsenic, (risk = 1.3E-05) Potassium-40, (risk = 5.1E-05) Thorium-232, (risk = 2.2E-04) Uranium-238 (risk = 2.8E-04) TCR = 5.7E-04

TCR Total cumulative risk

1) Radium-226 risk will be managed under the cleanup level established for the entire decay series. Radium-226 is a daughter product of the uranium-238 decay series.

C-4. REFERENCES

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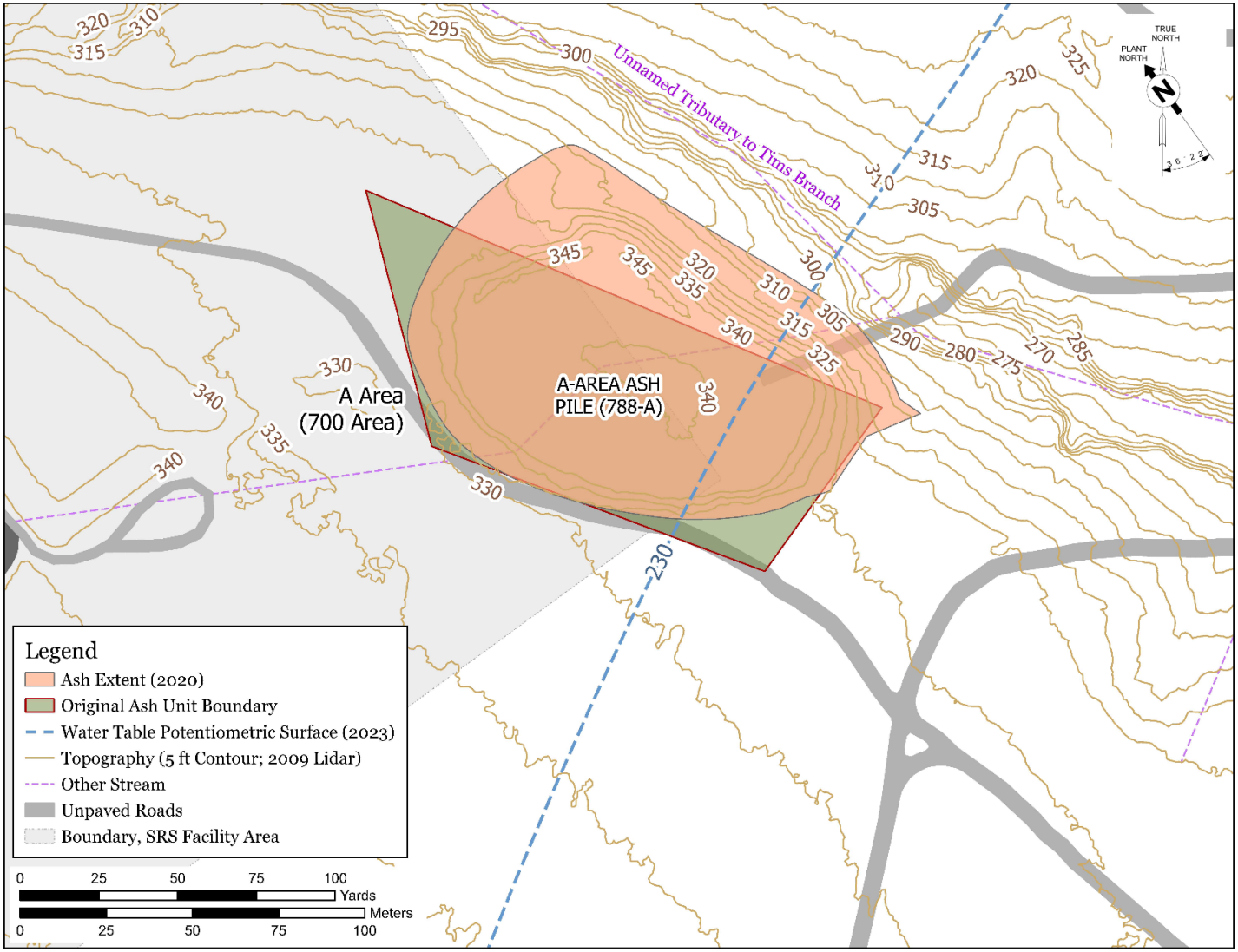


Figure C-1. AAP Unit Boundary and Ash Extent

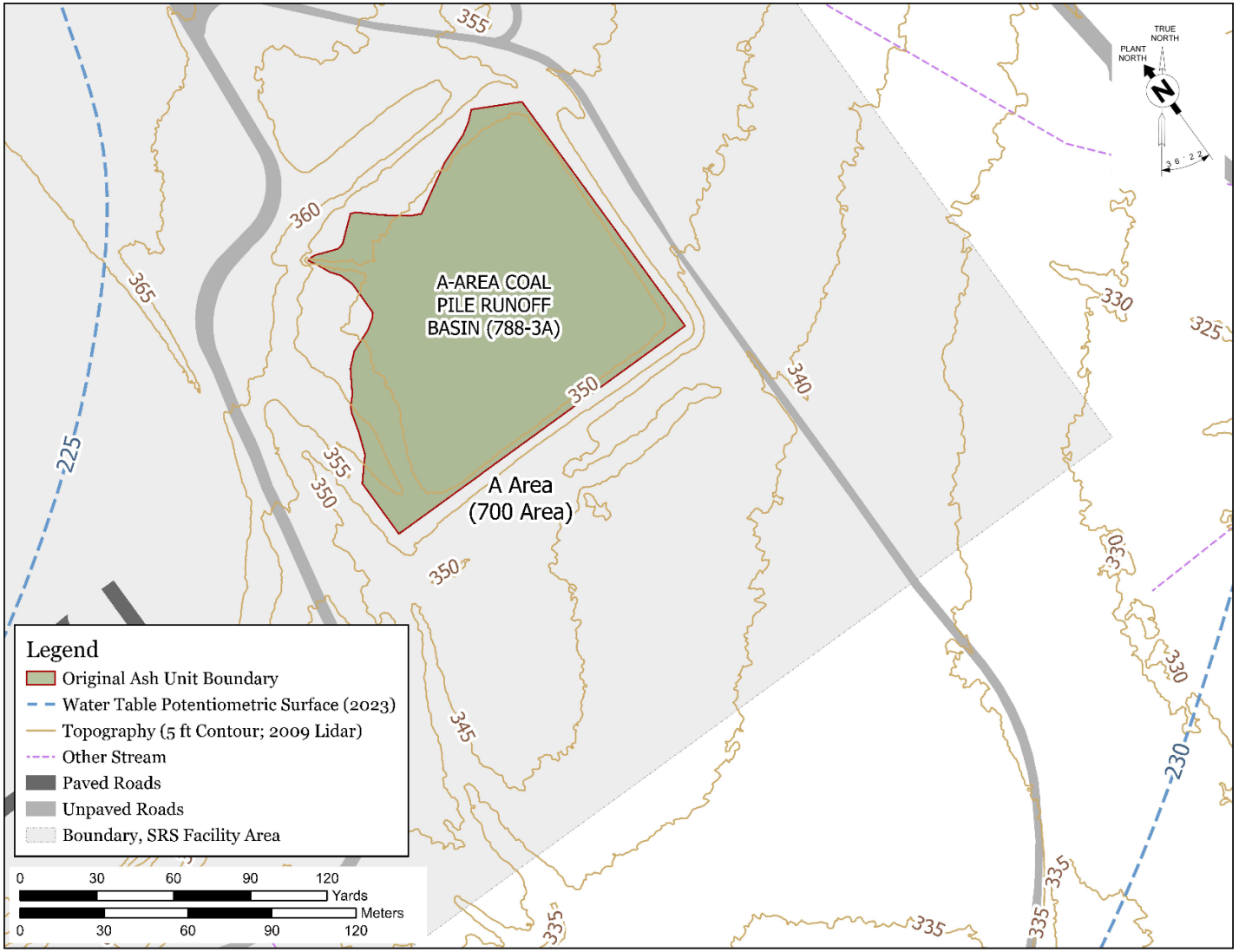


Figure C-2 ACPRB Unit Boundary

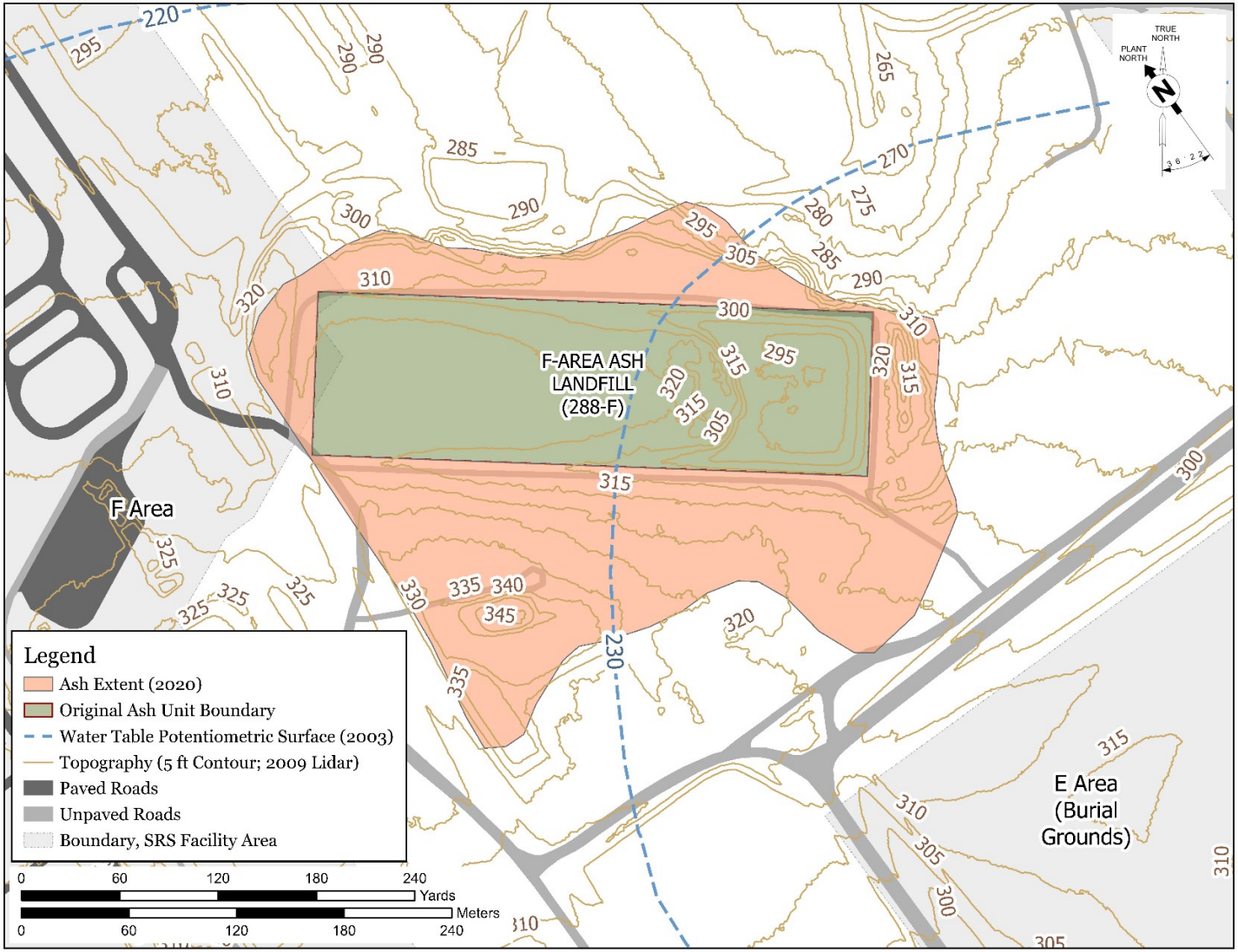


Figure C-3. FAL Unit Boundary and Ash Extent

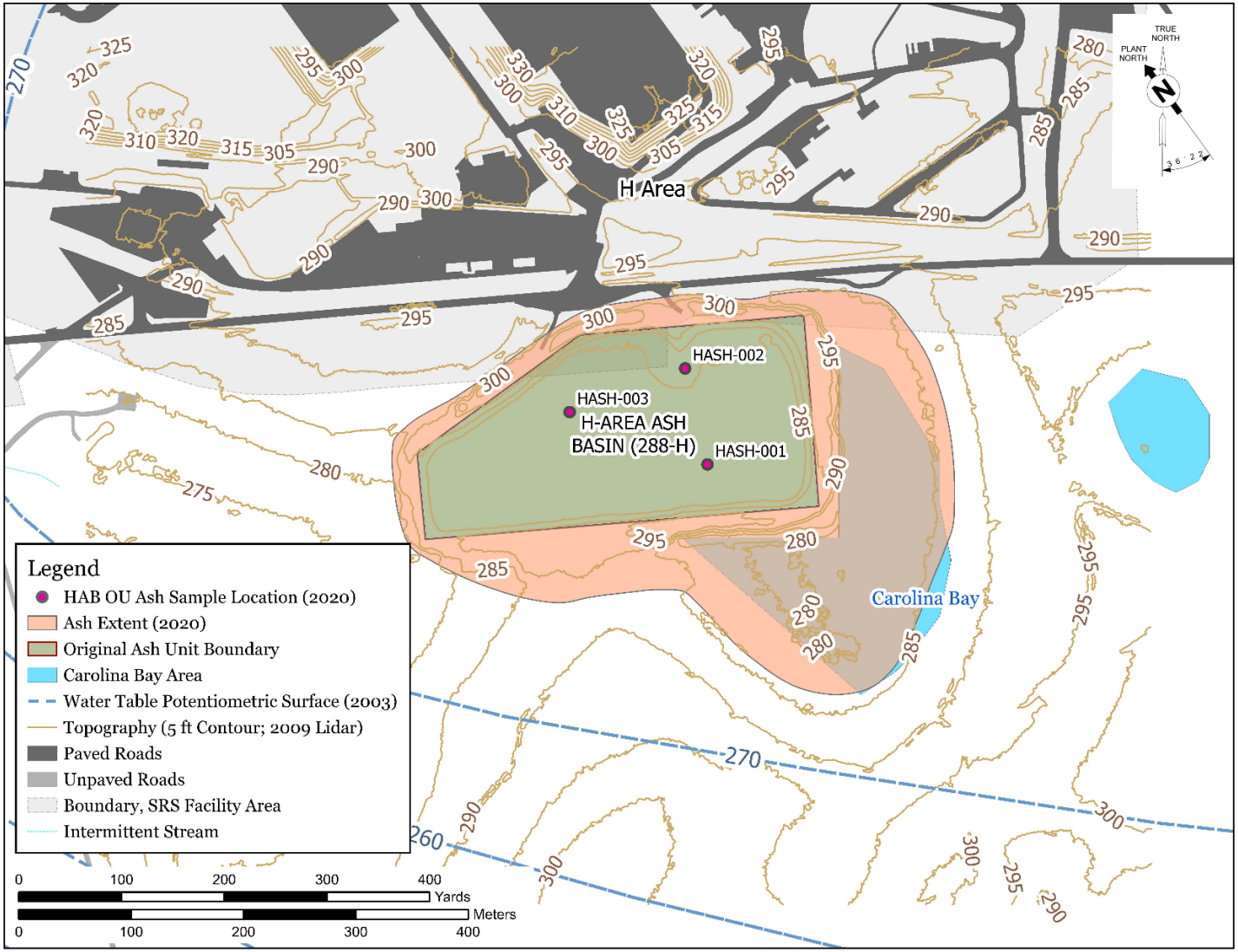


Figure C-4. HAB Unit Boundary and Ash Extent

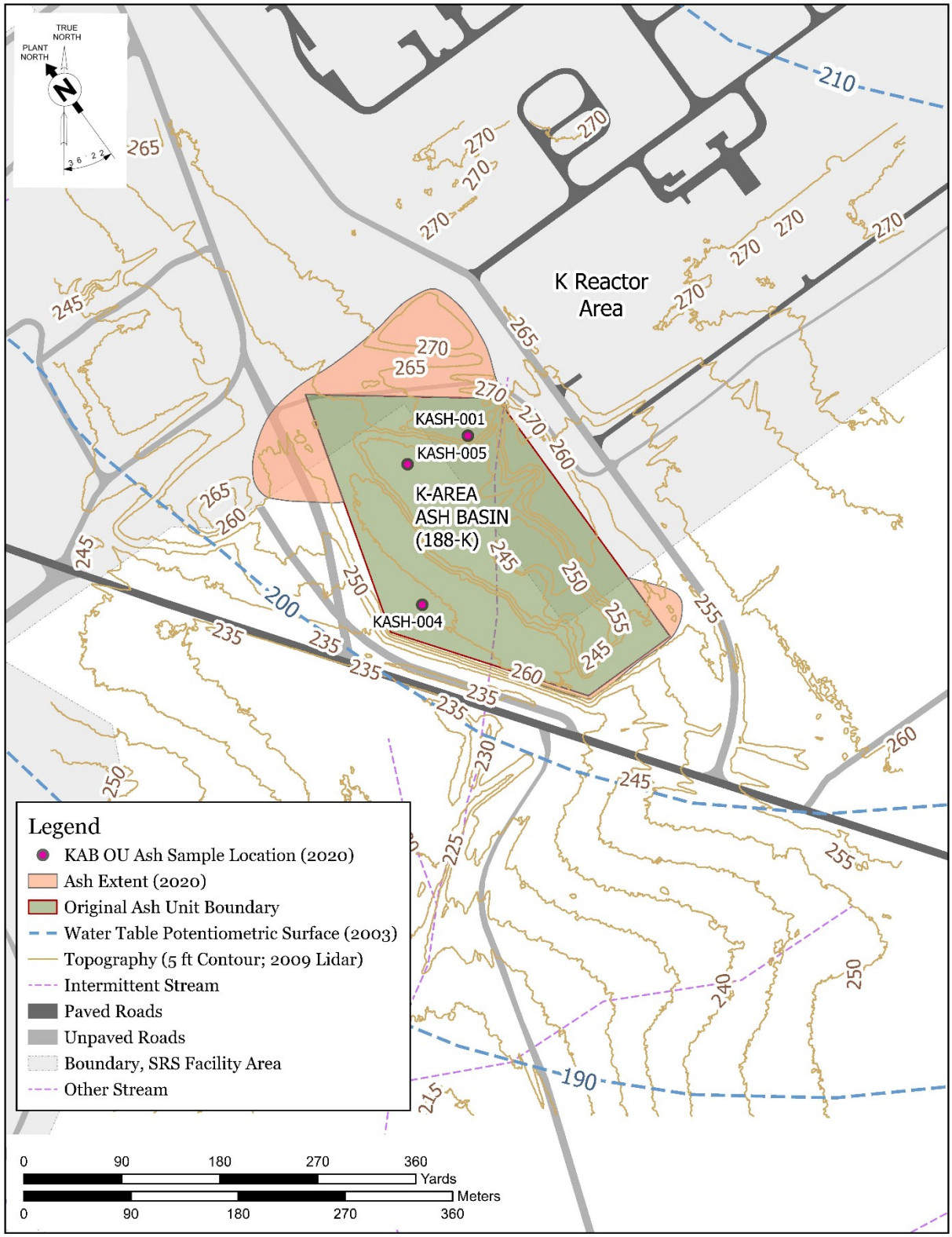


Figure C-5. KAB Unit Boundary and Ash Extent

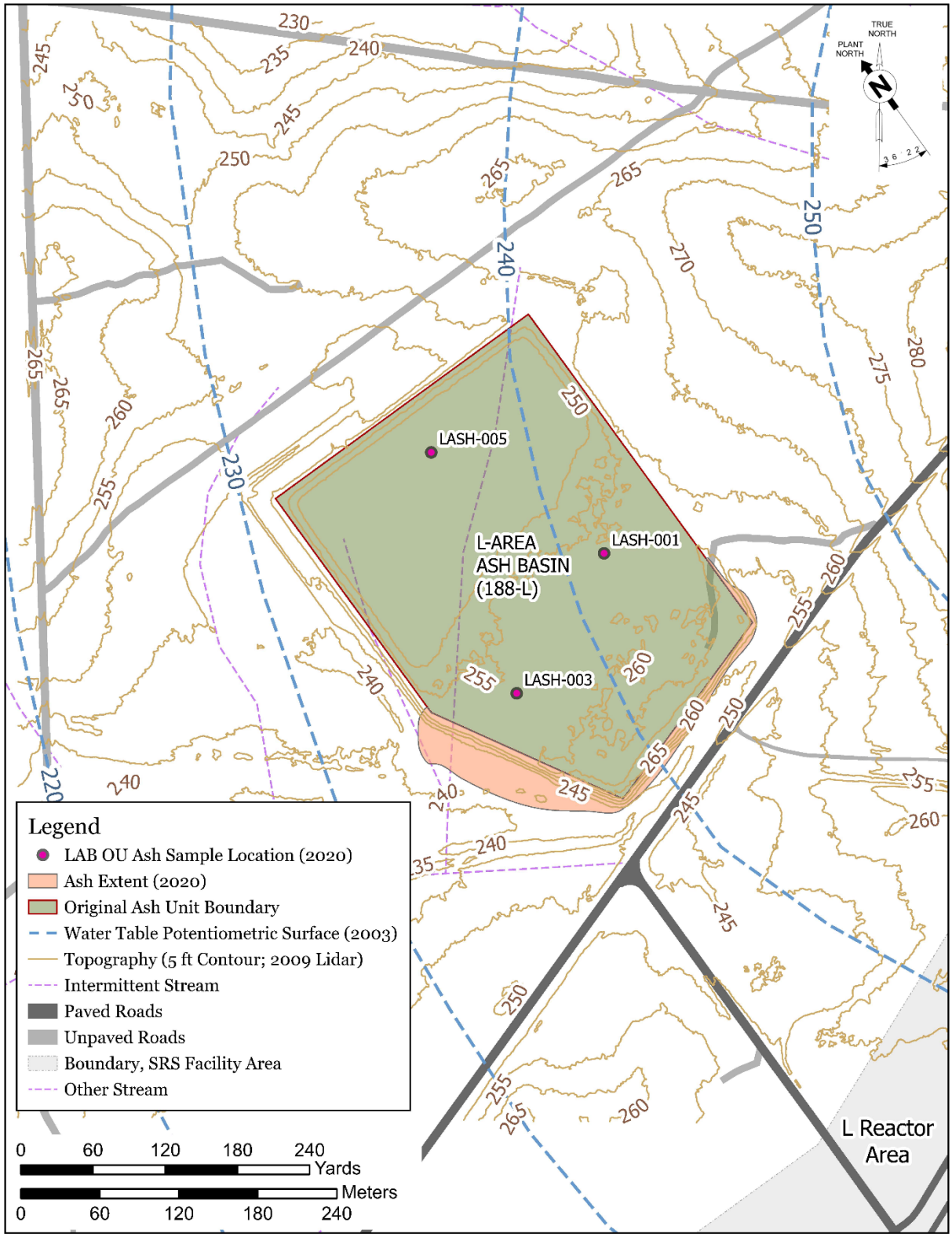


Figure C-6. LAB Unit Boundary and Ash Extent

Table C-1. Waste Unit Comparison of Arsenic Concentrations and Naturally Occurring Radionuclide Activities

HH COC	Units	SRS Bkgd	PAB	RAB	DCPRB	WADB	AAP	ACPRB	HAB	KAB	LAB	FAL
Arsenic	mg/kg	22.9	59.7	28.7	158	33.6	51.6	44.7	76.5	32.3	19.1	36.3
Potassium-40	pCi/g	8.53	13.8	16.9	NA	16.4	23.9	NA	11.3	12.5	10.8	na
Radium-228 (+D)	pCi/g	6.75	4.07	NA	NA	NA	NA	NA	4.15	2.91	2.63	na
Thorium-228 (+D)	pCi/g	4.17	3.94	NA	NA	NA	NA	NA	4.27	3.94	3.18	na
Uranium-238 (+D)	pCi/g	1.9	5.29	8.32	NA	2.51	2.68	NA	3.59	3.7	5.82	na
Radium-226 (+D)	pCi/g	1.74	5.4	8.08	NA	2.38	3.33	NA	4.04	4.12	8.63	na
Uranium-235 (+D)	pCi/g	0.17	NA	0.506	NA	NA	NA	NA	ND	ND	0.561	na

SRS Bkgd = Background Soils Statistical Summary Report for the Savannah River Site, ERD-EN-2005-0223, Rev 1, October 2006, Appendix B-2 (max detect, all depths)
PAB = P-Area Ash Basin
RAB = R-Area Ash Basin
DCPRB = D-Area Coal Pile Runoff Basin
WADB = Wetland Area at Dunbarton Bay
AAP = A-Area Ash Pile
ACPRB = A-Area Coal Pile Runoff Basin
HAB = H-Area Ash Basin
KAB = K-Area Ash Basin
LAB = L-Area Ash Basin
FAL = F-Area Ash Landfill
na = not analyzed
NA = not applicable
ND = not detected

Table C-2. Human Health COPC Screening for HAB, KAB, and LAB OUs Ash/Soil Media (0 to 0.3 m [0 to 1 ft])

Analyte	Detected Maximum Concentration[1]	Qualifier	Human Health Screening Value[2,6,7]	Human Health Screening Value Source	Exceeds Human Health Screening Value?	2X Average Background Concentration[3,7,8]	Exceeds 2X Average Background?[4]	COPC?[5]
Inorganics *(mg/kg)*								
ALUMINUM	2.16E+04		7.70E+03	0.1xRSL	YES	1.05E+04	YES	**YES**
ARSENIC	7.65E+01		6.80E-01	RSL	YES	4.28E+00	YES	**YES**
BARIUM	4.79E+02		1.50E+03	0.1xRSL	no	3.91E+01	YES	no
BERYLLIUM	5.06E+00		1.60E+01	0.1xRSL	no	2.88E-01	YES	no
CALCIUM	4.59E+04		EN	--	--	4.76E+02	YES	no
CHROMIUM	1.87E+01		3.00E-01	RSL	YES	1.54E+01	YES	**YES**
COBALT	1.01E+01		2.30E+00	0.1xRSL	YES	1.55E+00	YES	**YES**
COPPER	3.90E+01		3.10E+02	0.1xRSL	no	4.34E+00	YES	no
IRON	2.16E+04		5.50E+03	0.1xRSL	YES	1.27E+04	YES	**YES**
LEAD	1.25E+01		2.00E+01	0.1xRSL	no	1.03E+01	YES	no
MAGNESIUM	5.44E+03		EN	--	--	2.75E+02	YES	no
MANGANESE	2.30E+02		1.80E+02	0.1xRSL	YES	1.53E+02	YES	**YES**
MERCURY	1.03E-01		1.10E+00	0.1xRSL	no	7.10E-02	YES	no
NICKEL	1.55E+01		1.40E+02	0.1xRSL	no	3.48E+00	YES	no
POTASSIUM	1.95E+03		EN	--	--	2.16E+02	YES	no
SELENIUM	3.09E+00		3.90E+01	0.1xRSL	no	2.99E+00	YES	no
SODIUM	5.92E+02		EN	--	--	4.02E+01	YES	no
VANADIUM	4.88E+01		3.90E+01	0.1xRSL	YES	3.91E+01	YES	**YES**
ZINC	2.67E+01		2.30E+03	0.1xRSL	no	9.47E+00	YES	no

Table C-2. Human Health COPC Screening for HAB, KAB, and LAB OUs Ash/Soil Media (0 to 0.3 m [0 to 1 ft]) (*continued*)

Analyte	Detected Maximum Concentration[1]	Qualifier	Human Health Screening Value[2,6,7]	Human Health Screening Value Source	Exceeds Human Health Screening Value?	2X Average Background Concentration[3,7,8]	Exceeds 2X Average Background?[4]	COPC?[5]
Organics *(mg/kg)*								
2-METHYLNAPHTHALENE	4.15E-01		2.40E+01	0.1xRSL	no	NA	--	no
BENZO(G,H,I)PERYLENE	2.97E-02	J	NA	--	--	NA	--	no
BENZO[A]ANTHRACENE	3.26E-02	J	1.10E+00	RSL	no	NA	--	no
BENZO[A]PYRENE	1.52E-02	J	1.10E-01	RSL	no	NA	--	no
BENZO[B]FLUORANTHENE	3.75E-02		1.10E+00	RSL	no	NA	--	no
BIS(2-ETHYLHEXYL)PHTHALATE	1.65E-02	J	3.90E+01	RSL	no	NA	--	no
CHRYSENE	3.51E-02	J	1.10E+02	RSL	no	NA	--	no
DI-N-BUTYL PHTHALATE	2.46E-02		6.30E+02	0.1xRSL	no	NA	--	no
FLUORANTHENE	4.97E-02		2.40E+02	0.1xRSL	no	NA	--	no
INDENO[1,2,3-CD]PYRENE	1.30E-02		1.10E+00	RSL	no	NA	--	no
NAPHTHALENE	2.60E-01		2.00E+00	RSL	no	NA	--	no
PHENANTHRENE	2.28E-01		NA	--	--	NA	--	no
PYRENE	6.42E-02		1.80E+02	0.1xRSL	no	NA	--	no
Radionuclides *(pCi/g)*								
CESIUM-137	2.26E-01		6.05E-02	PRG	YES	2.84E-01	no	no
POTASSIUM-40	1.25E+01		1.44E-01	PRG	YES	2.33E+00	YES	**YES**

Table C-2. Human Health COPC Screening for HAB, KAB, and LAB OUs Ash/Soil Media (0 to 0.3 m [0 to 1 ft]) *(continued/end)*

Analyte	Detected Maximum Concentration[1]	Qualifier	Human Health Screening Value[2,6,7]	Human Health Screening Value Source	Exceeds Human Health Screening Value?	2X Average Background Concentration[3,7,8]	Exceeds 2X Average Background?[4]	COPC?[5]
***Radionuclides** (pCi/g) (continued)*								
THORIUM-232	3.90E+00		9.85E-03	PRG	YES	1.80E+00	YES	**YES**
RADIUM-228	1.10E+00		9.85E-03	+D-Th	YES	1.80E+00	no	no
ACTINIUM-228	4.15E+00		9.85E-03	+D-Th	YES	1.80E+00	YES	**YES**
THORIUM-228	4.27E+00		9.85E-03	+D-Th	YES	1.80E+00	YES	**YES**
LEAD-212	3.55E+00		9.85E-03	+D-Th	YES	1.80E+00	YES	**YES**
BISMUTH-212	4.23E+00		9.85E-03	+D-Th	YES	1.80E+00	YES	**YES**
THALLIUM-208	1.04E+00		9.85E-03	+D-Th	YES	1.80E+00	no	no
URANIUM-238	5.82E+00		1.25E-02	PRG	YES	1.01E+00	YES	**YES**
URANIUM-233/234	6.72E+00		1.25E-02	+D-U	YES	1.01E+00	YES	**YES**
THORIUM-230	8.02E+00		1.25E-02	+D-U	YES	1.01E+00	YES	**YES**
RADIUM-226	8.63E+00		1.25E-02	+D-U	YES	1.01E+00	YES	**YES**
LEAD-214	6.26E+00		1.25E-02	+D-U	YES	1.01E+00	YES	**YES**
BISMUTH-214	5.57E+00		1.25E-02	+D-U	YES	1.01E+00	YES	**YES**
URANIUM-235	5.61E-01	J	4.58E-02	PRG	YES	7.98E-02	YES	**YES**

1 - Maximum detected concentration from surface soil interval (0 to 0.3 m [0 to 1 ft]) from Table A.1.
2 - Nonradiological RSLs are residential soil default values from the generic USEPA Regional Screening Levels (RSLs) website, accessed June 2024 (see Attachment C-1). Radiological PRGs are site-specific residential soil values derived using the USEPA Radionuclide Preliminary Remediation Goals (PRGs) for Superfund website calculator and eliminating the fruit and vegetable pathways. All other inputs are default parameters, accessed June 2024. (see Attachment C-2).
3 - Background screening values obtained from Background Soils Statistical Summary Report for the Savannah River Site, Table B-1, ERD-EN-2005-0223, Rev 1, October 2006, Appendix B-1 (0 to 0.3 m [0 to 1 ft] interval).
4 - For screening purposes, maximum concentration of the naturally-occurring (nonanthopogenic) constituents are compared to 2X average background concentration.
5 - Constituents are identified as COPCs if the maximum detected concentration exceeds the human health screening value and the 2X average background concentration (if available).
6 - RSL for hexavalent chromium (most conservative) used.
7 - Radionuclides take into account secular equilibrium and therefore the parent PRG was used to screen the entire decay for the thorium-232 and uranium-238 series. If any of the radionuclides in the decay chain are identified as COPCs the parent nuclide is carried forward for risk calulations.
8 - Background concentration for total chromium used.
EN - essential nutrient; NA - not available

Table C-3. Human Health Risk/Hazard Calculation for HAB, KAB, and LAB OUs Ash/Soil Media (0 to 0.3 m [0 to 1 ft]) Residential Scenario

Analyte[1]	EPC[2,7]	Residential RSL/PRG[3,8]	Residential Hazard Estimate[4]	Residential Risk Estimate[5]	Target Organ	COC?[6]
Noncarcinogenic Hazard Estimate						
Chemical Constituents *(mg/kg)*						
ALUMINUM	1.07E+04	7.74E+04	1.38E-01	--	Neurological	no
ARSENIC	3.76E+01	3.49E+01	1.08E+00	--	Dermal	**YES**
CHROMIUM	1.28E+01	2.34E+02	5.47E-02	--	Other	no
COBALT	7.96E+00	2.34E+01	3.40E-01	--	Hematological	no
IRON	1.30E+04	5.48E+04	2.38E-01	--	Hepatic	no
MANGANESE	1.07E+02	1.83E+03	5.83E-02	--	Neurological	no
VANADIUM	3.30E+01	3.93E+02	8.38E-02	--	Dermal	no
	Total Hazard Index (HI)=		**1.99E+00**			
Carcinogenic Risk Estimate						
Chemical Constituents *(mg/kg)*						
ARSENIC	3.76E+01	6.77E-01	--	5.56E-05	NA	**YES**
CHROMIUM	1.28E+01	3.01E-01	--	4.25E-05	NA	**YES**
COBALT	7.96E+00	4.24E+02	--	1.88E-08	NA	no
		Total Chemical Risk =		**9.81E-05**		
Radionuclide Constituents *(pCi/g)*						
POTASSIUM-40	1.12E+01	1.44E-01	--	7.75E-05	NA	**YES**
THORIUM-232	3.42E+00	9.85E-03	--	3.47E-04	NA	**YES**
URANIUM-238	5.54E+00	1.25E-02	--	4.43E-04	NA	**YES**
URANIUM-235	5.61E-01	4.58E-02	--	1.22E-05	NA	**YES**
		Total Radionuclide Risk =		**8.80E-04**		
		Total Media Risk =		**9.78E-04**		

1 - Analytes from Table C-2 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 (see Table A.1).
3 - Nonradiological RSLs are residential soil default values from the USEPA Regional Screening Levels (RSLs) website, accessed June 2024 (see Attachment C-1). Radiological PRGs are site-specific residential soil values derived using the USEPA Radionuclide Preliminary Remediation Goals (PRGs) for Superfund website calculator and eliminating the fruit and vegetable pathways. All other inputs are default parameters, accessed June 2024 (see Attachment C-2).
4 - Residential Hazard Estimate = EPC/RSL
5 - Residential Risk Estimate = (EPC/[RSL or PRG])*1E-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 HI>1. For carcinogens, constituents are identified as COCs if the individual cancer risk ≥ 1E-06.
7 - For radionuclides within a decay chain (i.e., thorium-232 and uranium-238) the most conservative EPC (highest activity) within each series is used to estimate the risk. Risk is calculated using parent PRG.
8 - RSL for hexavalent chromium (most conservative) used.
NA - not applicable

Table C-3. Human Health Risk/Hazard Calculation for HAB, KAB, and LAB OUs Ash/Soil Media (0 to 0.3 m [0 to 1 ft]) Residential Scenario (*continued/end*)

Dermal	**ARSENIC**	**1.08E+00**
	VANADIUM	8.38E-02
	Total Dermal	**1.16E+00**
Neurological	ALUMINUM	1.38E-01
	MANGANESE	5.38E-02
	Total Neurological	**1.97E-01**
Hematological	COBALT	3.40E-01
	Total Hematological	**3.40E-01**
Hepatic	IRON	2.38E-01
	Total Hepatic	**2.38E-01**
Other	CHROMIUM	5.47E-02
	Total Other	**5.47E-02**

Table C-4. Human Health Risk/Hazard Calculation for HAB, KAB, and LAB OUs Ash/Soil Media (0 to 0.3 m [0 to 1 ft]) Industrial Scenario

Analyte[1]	EPC[2,7]	Industrial RSL/PRG[3,8]	Industrial Hazard Estimate[4]	Industrial Risk Estimate[5]	Target Organ	COC?[6]
Noncarcinogenic Hazard Estimate						
Chemical Constituents *(mg/kg)*						
ALUMINUM	1.07E+04	1.12E+06	9.57E-03	--	Neurological	no
ARSENIC	3.76E+01	4.79E+02	7.85E-02	--	Dermal	no
CHROMIUM	1.28E+01	3.48E+03	3.68E-03	--	Other	no
COBALT	7.96E+00	3.47E+02	2.29E-02	--	Hematological	no
IRON	1.30E+04	8.18E+05	1.59E-02	--	Hepatic	no
MANGANESE	1.07E+02	2.56E+04	4.17E-03	--	Neurological	no
VANADIUM	3.30E+01	5.83E+03	5.65E-03	--	Dermal	no
	Total Hazard Index (HI)=		**1.40E-01**			
Carcinogenic Risk Estimate						
Chemical Constituents *(mg/kg)*						
ARSENIC	3.76E+01	3.00E+00	--	1.25E-05	NA	**YES**
CHROMIUM	1.28E+01	6.33E+00	--	2.02E-06	NA	**YES**
COBALT	7.96E+00	1.85E+03	--	4.30E-09	NA	no
		Total Chemical Risk=		**1.46E-05**		
Radionuclide Constituents *(pCi/g)*						
POTASSIUM-40	1.12E+01	2.19E-01	--	5.10E-05	NA	**YES**
THORIUM-232	3.42E+00	1.53E-02	--	2.24E-04	NA	**YES**
URANIUM-238	5.54E+00	2.00E-02	--	2.77E-04	NA	**YES**
URANIUM-235	5.61E-01	7.31E-02	--	7.67E-06	NA	**YES**
		Total Radionuclide Risk =		**5.60E-04**		
		Total Media Risk =		**5.74E-04**		

1 - Analytes from Table C-2 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 (see Table A.1).
3 - Nonradiological RSLs are industrial soil default values from the USEPA Regional Screening Levels (RSLs) website, accessed June 2024 (see Attachment C-1). Radiological PRGs are industrial soil default values from the USEPA Radionuclide Preliminary Remediation Goals (PRGs) for Superfund website, accessed June 2024 (see Attachment C-3).
4 - Industrial Hazard Estimate = EPC/RSL
5 - Industrial Risk Estimate = (EPC/[RSL or PRG])*1E-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. Constituents are identified as COCs if the total organ HI > 1. For carcinogens, constituents are identified as COCs if the individual cancer risk ≥ 1E-06.
7 - For radionuclides within a decay chain (i.e., thorium-232 and uranium-238) the most conservative EPC (highest activity) within each series is used to estimate the risk. Risk is calculated using parent PRG.
8 - RSL for hexavalent chromium (most conservative) used.
NA - not applicable

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Attachment C-1
USEPA Regional Screening Levels Table
RSLs for Default Resident and Default Industrial Worker Scenarios

Website accessed June 2024

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USEPA Regional Screening Levels Table *RSLs for Default Resident and Default Industrial Worker Scenarios*

SFO (mg/kg-day)$^{-1}$	key	IUR (ug/m^3)$^{-1}$	key	RfD_o (mg/kg-day)	key	RfC_i (mg/m^3)	key	VOC	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Tap Water (ug/L)	key	MCL (ug/L)
Inorganics																	
				1.0E+00	P	5.0E-03	P		Aluminum	7429-90-5	7.7E+04	n	1.1E+06	nm	2.0E+04	n	
1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C		Arsenic, Inorganic	7440-38-2	6.8E-01	c*G	3.0E+00	cG	5.2E-02	c	1.0E+01
				2.0E-01	I	5.0E-04	H		Barium	7440-39-3	1.5E+04	n	2.2E+05	nm	3.8E+03	n	2.0E+03
		2.4E-03	I	2.0E-03	I	2.0E-05	I		Beryllium and compounds	7440-41-7	1.6E+02	n	2.3E+03	n	2.5E+01	n	4.0E+00
5.0E-01	C	8.4E-02	G	3.0E-03	I	1.0E-04	I		Chromium (VI)	18540-29-9	3.0E-01	c	6.3E+00	c	3.5E-02	c	
		9.0E-03	P	3.0E-04	P	6.0E-06	P		Cobalt	7440-48-4	2.3E+01	n	3.5E+02	n	6.0E+00	n	
				4.0E-02	H				Copper	7440-50-8	3.1E+03	n	4.7E+04	n	8.0E+02	n	1.3E+03
				7.0E-01	P				Iron	7439-89-6	5.5E+04	n	8.2E+05	nm	1.4E+04	n	
									Lead and Compounds	7439-92-1	2.0E+02	G	8.0E+02	G	1.5E+01	G	1.5E+01
				2.4E-02	G	5.0E-05	I		Manganese (Non-diet)	7439-96-5	1.8E+03	n	2.6E+04	n	4.3E+02	n	
						3.0E-04	I	V	Mercury (elemental)	7439-97-6	1.1E+01	ns	4.6E+01	ns	6.3E-01	n	2.0E+00
		2.6E-04	C	2.0E-02	I	1.4E-05	T		Nickel Soluble Salts	7440-02-0	1.4E+03	n	1.7E+04	n	3.9E+02	n	
				5.0E-03	I	2.0E-02	C		Selenium	7782-49-2	3.9E+02	n	5.8E+03	n	1.0E+02	n	5.0E+01
				5.0E-03	G	1.0E-04	A		Vanadium and Compounds	7440-62-2	3.9E+02	n	5.8E+03	n	8.6E+01	n	
				3.0E-01	I				Zinc and Compounds	7440-66-6	2.3E+04	n	3.5E+05	nm	6.0E+03	n	
Organics																	
				4.0E-03	I			V	~Methylnaphthalene, 2-	91-57-6	2.4E+01	n	3.0E+02	n	3.6E+00	n	
1.0E-01	E	6.0E-05	E					V	Benz[a]anthracene	56-55-3	1.1E+00	c	2.1E+01	c	3.0E-02	c	
1.0E+00	I	6.0E-04	I	3.0E-04	I	2.0E-06	I		Benzo[a]pyrene	50-32-8	1.1E-01	c	2.1E+00	c	2.5E-02	c	2.0E-01
1.0E-01	E	6.0E-05	E						Benzo[b]fluoranthene	205-99-2	1.1E+00	c	2.1E+01	c	2.5E-01	c	
1.4E-02	I	2.4E-06	C	2.0E-02	I				Bis(2-ethylhexyl)phthalate	117-81-7	3.9E+01	c*	1.6E+02	c	5.6E+00	c*	6.0E+00
1.0E-03	E	6.0E-07	E						Chrysene	218-01-9	1.1E+02	c	2.1E+03	c	2.5E+01	c	
				1.0E-01	I				Dibutyl Phthalate	84-74-2	6.3E+03	n	8.2E+04	n	9.0E+02	n	
				4.0E-02	I				Fluoranthene	206-44-0	2.4E+03	n	3.0E+04	n	8.0E+02	n	
1.0E-01	E	6.0E-05	E						Indeno[1,2,3-cd]pyrene	193-39-5	1.1E+00	c	2.1E+01	c	2.5E-01	c	
1.2E-01	C	3.4E-05	C	2.0E-02	I	3.0E-03	I	V	~Naphthalene	91-20-3	2.0E+00	c**	8.6E+00	c**	1.2E-01	c**	
				3.0E-02	I			V	Pyrene	129-00-0	1.8E+03	n	2.3E+04	n	1.2E+02	n	

A = Agency for Toxic Substances and Disease Registry (ATSDR)
C = California EPA
E = Relative Potency Factor
G = User's Guide
H = Health Effects Assessment Summary Tables (HEAST)
I = Integrated Risk Information System (IRIS)
P = Provisional Peer-Reviewed Toxicity Values
T = ATSDR DRAFT
V = volatile organic compound
c = cancer
m = ceiling limit exceeded
n = noncancer
* = where: n SL < 100X c SL
** = where n SL < 10X c SL
SFO = oral slope factor
IUR = inhalation unit risk
RfD_o = chronic oral reference dose
RfC_i = chronic inhalation reference concentration

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Attachment C-2
USEPA Radionuclide Preliminary Remediation Goals Website
Site-Specific PRGs for Resident Scenario

(Website accessed June 2024)

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Site-Specific Resident Equation Inputs for Soil

Variable	Site-Specific Value	Variable	Site-Specific Value
A (PEF Dispersion Constant)	16.2302	ET_{res-i} (soil exposure time - indoor resident) hr/day	16.416
B (PEF Dispersion Constant)	18.7762	ET_{res-o} (soil exposure time - outdoor resident) hr/day	1.752
City (Climate Zone)	Default	GSF_i (gamma shielding factor - indoor) unitless	0.4
C (PEF Dispersion Constant)	216.108	$IFA_{res-adj}$ (age-adjusted soil inhalation factor - resident) m^3	161000
Cover thickness for GSF_o (gamma shielding factor) cm	0 cm	$IFS_{res-adj}$ (age-adjusted soil ingestion factor - resident) mg	1120000
Cover thickness for GSF_b (gamma shielding factor) cm	0 cm	IRA_{res-a} (soil inhalation rate - resident adult) m^3/day	20
$CF_{res-produce}$ (contaminated plant fraction) unitless	0	IRA_{res-c} (soil inhalation rate - resident child) m^3/day	10
ED_{res-a} (produce exposure duration - resident adult) yr	0	IRS_{res-a} (soil intake rate - resident adult) mg/day	100
ED_{res-c} (produce exposure duration - resident child) yr	0	IRS_{res-c} (soil intake rate - resident child) mg/day	200
EF_{res-a} (produce exposure frequency - resident adult) day/yr	0	t_{res} (time - resident) yr	26
EF_{res-c} (produce exposure frequency - resident child) day/yr	0	TR (target cancer risk) unitless	0.000001
TR (produce target cancer risk) unitless	0.000001	Soil type	Default
F(x) (function dependent on U_m/U_t) unitless	0.194	U_m (mean annual wind speed) m/s	4.69
PEF (particulate emission factor) m^3/kg	1359344438	U_t (equivalent threshold value)	11.32
Q/C_{wind} (g/m^2-s per kg/m^3)	93.77	V (fraction of vegetative cover) unitless	0.5
A_s (acres)	0.5		
Site area for ACF (area correction factor) m^2	1000000 m^2		
ED_{res} (soil exposure duration - resident) yr	26		
ED_{res-a} (soil exposure duration - resident adult) yr	20		
ED_{res-c} (soil exposure duration - resident child) yr	6		
EF_{res} (soil exposure frequency - resident) day/yr	350		
EF_{res-a} (soil exposure frequency - resident adult) day/yr	350		
EF_{res-c} (soil exposure frequency - resident child) day/yr	350		
ET_{res} (soil exposure time - resident) hr/day	24		
ET_{res-a} (soil exposure time - resident adult) hr/day	24		
ET_{res-c} (soil exposure time - resident child) hr/day	24		

Site-Specific Resident PRGs for Soil

Isotope	Ingestion PRG *(pCi/g)*	InhalationPRG *(pCi/g)*	External Exposure PRG *(pCi/g)*	Total PRG *(pCi/g)*
Peak PRG for Cesium-137	2.79E+01	9.97E+04	6.06E-02	6.05E-02
Peak PRG for Potassium-40	1.53E+01	3.80E+04	1.45E-01	1.44E-01
Peak PRG for Thorium-232	3.08E-01	3.65E+01	1.02E-02	9.85E-03
Peak PRG for Uranium-235	6.08E-01	2.69E+01	4.96E-02	4.58E-02
Peak PRG for Uranium-238	1.44E-01	5.84E+01	1.36E-02	1.25E-02

PRG = preliminary remediation goal
NA = not applicable

Attachment C-3
USEPA Radionuclide Preliminary Remediation Goals for Superfund Table: Default PRGs for Industrial Worker Scenario

(Website accessed June 2024)

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Default Industrial Worker Equation Inputs for Soil

Radionuclide		Isotope-specific Information		PRG
Element (Atomic Number)	Isotope	Lambda (1/yr)	Half-life (yr)	Composite Worker Soil Total PRG TR=1E-06 (pCi/g)
Cesium (55)	Cesium-137	2.30E-02	3.02E+01	9.07E-02
Potassium (19)	Potassium-40	5.54E-10	1.25E+09	2.19E-01
Thorium (90)	Thorium-232	4.93E-11	1.41E+10	1.53E-02
Uranium (92)	Uranium-235	9.84E-10	7.04E+08	7.31E-02
Uranium (92)	Uranium-238	1.55E-10	4.47E+09	2.00E-02

PRG = preliminary remediation goal

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APPENDIX D

ECOLOGICAL RISK ASSESSMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

AAP	A-Area Ash Pile (788-A) (AAP)
ACPRB	A-Area Coal Pile Runoff Basin (788-3A) (ACPRB)
amsl	above mean sea level
BRA	Baseline Risk Assessment
CMS	Corrective Measures Study
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	Conceptual Site Model
DABW	D-Area Ash Basin Wetlands
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
ESV	ecological screening value
FAL	F-Area Ash Landfill (288-F) (FAL)
FS	Feasibility Study
ft	feet
HAB	H-Area Ash Basin (288-H) (HAB)
HQ	hazard quotient
KAB	K-Area Ash Basin (188-K)
LAB	L-Area Ash Basin (188-L)
LANL	Los Alamos National Laboratory
LOAEL	Low Observed Adverse Effect Level
m	meter
NOAEL	No Observed Adverse Effect Level
OU	operable unit
pCi/g	picocuries per gram
RCOC	refined constituent of concern
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RI	remedial investigation
RME	reasonable maximum exposure
RSV	refinement screening values

LIST OF ABBREVIATIONS AND ACRONYMS *(Continued/End)*

SRS	Savannah River Site
TRV	Toxicity Reference Values
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
WADB	Wetland Area at Dunbarton Bay

D-1. INTRODUCTION

The ecological risk assessment (ERA) presented in this appendix supports the Focused Corrective Measure Study/Feasibility Study (CMS/FS) for a wholistic remedial approach to address several of the remaining coal ash and coal fines operable units (OUs) at the Savannah River Site (SRS) that includes future beneficial reuse of the ash material. The units include A-Area Ash Pile (788-A) (AAP) and A-Area Coal Pile Runoff Basin (788-3A) (ACPRB) OU, F-Area Ash Landfill (288-F) (FAL) OU, H-Area Ash Basin (288-H) (HAB) OU, K-Area Ash Basin (188-K) (KAB) OU, and the L-Area Ash Basin (188-L) (LAB) OU, herein referred to as the remaining coal ash and coal fines OUs (Figure D-1).

The ERA process is conducted in accordance with the protocols in the *Environmental Compliance Area Completion Projects (EC&ACP) Regulatory Document Handbook* (SRNS 2023) and the preliminary conceptual site model (CSM) presented in Section 1.2.3, in the body of this document, in the Focused CMS/FS and depicted in Figures 10 – 15 for the AAP, ACPRB, FAL, HAB, KAB, and LAB, respectively. The CSM is a graphical depiction of the known and suspected sources of contamination within the remaining coal ash and coal fines OUs, the types of contaminants and potentially affected media, the known and potential routes of migrations, and the potential ecological receptors, including terrestrial and aquatic/semi-aquatic receptors. Concentrations of constituents present in soil are screened in a multi-step process against ecological thresholds to determine the potential impact to either of the receptor groups.

Each unit contains environmental media that a receptor may be exposed, surface ash/soil, allowing for the screening of data and an evaluation of potential exposure. The ERA is conducted and presented in the following sections for the FAL, HAB, KAB, and LAB OUs. An ERA was previously conducted for the AAP and ACPRB OU in 2012 (SRNS 2012) with refined COCs (RCOCs) identified for the ACPRB. An uncertainty evaluation was performed on the ACPRB RCOCs in this ERA based on current environmental conditions.

D-1.1 Background

The remaining coal ash and coal fines OUs are described below. A more detailed description is provided in Chapter 1 of this Focused CMS/FS.

D-1.1.1 A-Area Ash Pile (788-A) and A-Area Coal Pile Runoff Basin (788-3A) Operable Unit

The AAP is located in A-Area within the Upper Three Runs watershed and is adjacent to an unnamed tributary to Tims Branch. The AAP encompasses 0.65 hectares [ha] (1.60 acres [ac]) and is located south of the ACPRB (788-3A). The AAP and contains bottom ash and fly ash received from the coal-fired A-Area Boiler House (784-A) between 1952 and 1978 with an estimated volume of 53,518 cubic meters [m^3] (70,000 cubic yards [yd^3)]). Grade level at the AAP ranges from 99 to 101 meters (m) (325 to 330 feet [ft]) (above mean sea level [amsl]), and the elevation at the top of the pile is approximately 105 m (345 ft) amsl, 4.6 to 6.1 m (15 to 20 ft) above grade. During operation of the AAP, the pile was graded, the top leveled, and the north side (stream side) benched. AAP is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. The banks of the adjacent tributary to Tims Branch were significantly scoured, and erosion threatened the stability of the ash pile until sheet piling and other erosion control measures were installed in the tributary in the early 2000s.

The ACPRB (Figure D-3) was constructed in 1978 and operated until the coal-fired A-Area Boiler House (784-A) ceased operation in 2008. Runoff from the coal storage pile was collected/transported in ditches and underground pipes that discharged to the ACPRB. The basin is an unlined earthen surface impoundment surrounded by earthen berms covering approximately 1.06 ha (2.62 ac). Elevations across the basin range from 105 to 108 m (344 to 355 ft) amsl. The estimated volume of ash/fines at the ACPRB is estimated at 7,645 m^3 (10,000 yd^3). The ACPRB is inactive and receives water only via precipitation. The basin has undergone secondary succession since operations ceased. There is no appreciable surface water present in the basin.

The AAP and ACPRB were investigated via the Remedial Investigation/Feasibility Study (RI/FS) process in 2008 and documented in the *Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-*

Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit (SRNS 2012). Ecological RCOCs were identified for the ACPRB for the sediment/coal fines and the surface water media. The ACPRB RCOCs are evaluated further in the refinement of RCOCs step in Section D-3.4 based on current environmental conditions.

D-1.1.2 F-Area Landfill (288-F) Operable Unit

The FAL is located in the Upper Three Runs watershed between F and H Areas (Figure D-1 and Figure D-4). FAL is an active Class II Landfill and consists of the active landfill and the area outside the landfill boundary where ash deposits are known to exist. The FAL became operational in 1954 and received ash from the A-, F-, and H-Area powerhouses during its operational history. The interior area of the FAL is ~ 2.84 ha (7.01 ac) with engineered storm water controls in place. As of August 2023, the volume of ash within the FAL was calculated to be ~151,457 m^3 (198,099 yd^3). Additional ash outside of the landfill is estimated to have an area of 4.64 ha (11.47 ac) and a volume of 11,743 m^3 (15,360 yd^3). The total area of ash is ~7.48 ha (18.48 ac) and the total volume of ash at the FAL OU is ~163,201 m^3 (213,459 yd^3).

D-1.1.3 H-Area Ash Basin (288-H) Operable Unit

The HAB (Figure D-5) received ash via wet ash slurry sluice from the H-Area Powerhouse (284-H); the powerhouse operated from 1950 to 1990. All operating systems in the H-Area powerhouse have been shut down. In 1993 to 1994 ~76,455 m^3 (100,000 yd^3) of ash was removed from the basin and transported to FAL and F-Area Ash Basin (288-1F). A Carolina bay is partially located within and extends beyond the southeastern boundary of the HAB. The HAB includes wet soils/ash that align with the boundary of the Carolina bay.

The HAB is ~ 5.29 ha (13.06 ac) and the estimated volume of ash within the boundary is ~84,944 m^3 (111,103 yd^3). Additional ash outside of the basin boundary is estimated to have an area of ~7.45 ha (18.40 ac) and a volume of 113,161 m^3 (148,009 yd^3). The total area of ash within and outside of the basin boundary is ~12.73 ha (31.46 ac). The total volume of ash inside and outside the basin boundary is ~198,019 m^3 (259,000 yd^3). The basin is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. Standing water has been encountered in the southeast side and outside of the boundary of the basin.

D-1.1.4 K-Area Ash Basin (188-K) Operable Unit

The KAB is located southwest of the K-Reactor Complex (105-K) and is in the Pen Branch watershed (Figure D-1 and D-6). The KAB received ash from the coal-fired K-Area Powerhouse (184-K), which operated from 1951 to 1990, via wet sluice. The KAB is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. The area of the basin is ~4.52 ha (11.16 ac); however, ash was discovered beyond the basin covering approximately an additional 1.54 ha (3.81 ac). The volume of ash within the boundary is ~194,627 m^3 (254,563 yd^3). Estimates using historical topographic data and ground surface Light Detection and Ranging (LiDAR) data indicate an ash volume of ~ 208,723 m^3 (273,000 yd^3).

D-1.1.5 L-Area Ash Basin (188-L) Operable Unit

The LAB is located northeast of the L-Reactor Complex (105-L) within the Pen Branch watershed (Figure D-1 and Figure D-7). The LAB received ash from the coal-fired L-Area Powerhouse (184-L), which operated from 1951 to 1968, via wet sluice. Currently, the LAB is heavily vegetated with mature pines, hardwoods, and a dense undergrowth. The northern portion of the basin has been observed with standing water. The interior area of the basin is ~7.13 ha (17.61 ac), with ash present over about 0.68 ha (1.67 ac) exterior to the basin. The volume of fly ash and bottom ash is estimated to be ~246,971 m^3 (323,026 yd^3) including ash deposits inside and outside the basin.

D-1.2 Data

This ERA considers ash/soil as the environmental medium associated with the remaining coal ash and coal fines OUs. Characterization data for the AAP/ACPRB OU was presented and evaluated in the RFI/RI Work Plan and RFI/RI/BRA/CMS/FS (SRNS 2012). These data are not re-evaluated herein. For the H-, K-, and L-Area Ash Basins, these three basins were sampled according to a Sampling and Analysis Plan that was developed in 2020 (SRNS 2020) in support of this Focused CMS/FS and beneficial reuse of ash material. The sampling consisted of three surface soil (ash/soil) samples collected from the HAB, KAB, and LAB in May 2020 and analyzed for Target Analyte List (TAL) / Target Compound List (TCL) semi-volatile (SVOCs) constituents, cesium-137, and hexavalent chromium (Figure D-2). These data were combined into one dataset consisting of nine sample results (three locations per basin) and processed in accordance with the protocols

in the Environmental Compliance & Area Completion Project Regulatory Document Handbook (SRNS 2023). Data collection was limited to the surface interval and was primarily collected to determine if the ash in these units was comparable to other ash units on the SRS. Table 1 of the Focused CMS/FS demonstrates that concentrations of arsenic and naturally occurring radionuclides (and corresponding human health risk levels of these constituents) for recently collected HAB, KAB, LAB data are consistent with other SRS ash waste units, including OUs that have gone through a formal baseline risk assessment (BRA) process such as the AAP/ACPRB OU. Table 1 also includes data from a *Waste Characterization Report for Savannah River Site Ash Outside 288-F Landfill* (discussed in Section 1.2 of the Focused CMS/FS) for the permitted FAL showing arsenic levels are consistent, and naturally occurring radionuclide activities are expected to be consistent as well.

The combined dataset from the HAB, KAB and LAB is applied to the ERA for these units, as well as the FAL, as agreed upon by the Core Team at the November 2, 2023, Focused CMS/FS scoping meeting for the remaining coal ash and coal fines OUs. The data also supports the contaminant migration analysis (Appendix B), human health risk assessment (Appendix C), and principal threat source material (PTSM) evaluation (Appendix E).

The data used in this ERA are presented in Appendix A. The ProUCL software package was used to calculate the 95% upper confidence limit (UCL) on the arithmetic mean (USEPA 2022). The data distribution and recommended 95% UCL, as determined by ProUCL for each constituent, are presented in Appendix A. Non-detected constituent concentrations were processed in accordance with the ProUCL User's Guide.

Groundwater is not part of the ecological evaluation for the remaining coal ash and coal fines OUs. Groundwater is addressed in Appendix B for the contaminant migration analysis.

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

In general, the remaining coal ash and coal fines OUs are located in upland areas and are represented by mature forested habitats, primarily pine dominated with hardwoods, shrub-scrub species, vines, and various herbaceous species. The habitats primarily support terrestrial receptors. As discussed in the RFI/RI Work Plan and RFI/RI/BRA/CMS/FS for the AAP and ACPRB (SRNS

2012), from an ecological risk perspective, the AAP and ACPRB OU does not provide prime wildlife habitat but does offer marginal resources (e.g., vegetative cover and/or water in the case of the ACPRB) that may attract ecological receptors to some degree. The AAP and ACPRB OU is similar to the other remaining coal ash and coal fines OUs that are undergoing/have undergone secondary secession since operations have ceased. Over time, the marginal aquatic habitat at the ACPRB becomes much less appreciable through secondary succession. For the HAB, wet conditions along the southeastern boundary have been observed based on field visits conducted in 2020 that align with the known/suspected Carolina bay that resides within the southeastern boundary. The LAB also has had standing water observed/present during two previous field visits in 2020.

Threatened, endangered, and sensitive (TES) species surveys, including rare species, are conducted at the SRS for both flora and fauna. The description of the site is typically described based on flora observations to provide an overall description of the habitat that indicates what fauna that may reside in/visit the area. Any TES species observed during the survey are noted, as well as habitats that may support TES or rare species, in describing the results of the TES surveys. A TES species survey was conducted in 1994 (USFS 1994a) in and around the ACPRB. Longleaf and loblolly pines predominated. Also noted were post and turkey oak, hackberry, a variety of shrubs (including wax myrtle and singed sumac), and various vines and hardwood species. Only one TES plant, little bur-head (*Echinodorus tenellus*), was found within a two-mile radius of the site, but this wetland species should not occur in the area of the ACPRB. The habitats in the vicinity of the ACPRB and surrounding area, including AAP, generally do not meet the specialized needs of most SRS TES species.

A TES species survey was conducted in 1994 for approximately 1500 acres within/surrounding the F-Area Burial Ground Complex and waste units including the FAL (USFS 1994b). Field surveys found very little in the way of specialized habitats that may support TES species. The few TES species identified were associated with Carolina bays or mesic valley conditions associated with floodplains or marginal wetlands located within/near wet areas. The area within and around the FAL is a highly modified upland habitat with little undisturbed areas. TES species are unlikely because of disturbance and historic uses.

A TES species survey was also conducted for the K-Area Bingham Pump Outage Pits that also included the footprint of the KAB encompassing portions of three timber compartments (USFS 1994c). Loblolly pine predominates that area south of K Area. Other canopy species include sweet gum, red maple, and persimmon. Slash pine dominated west of K Area. A small population of Nestronia (*Nestronia umbellule*) (rare/sensitive species) was observed in the southwest portion of the area within a stand of black oak, hickory, and scarlet oak. This species is typically found within upland mixed hardwood and wetland mixed hardwood habitats. No specialized habitats were identified that would support TES species within/near the KAB. In terms of fauna, the bald eagle likely uses the survey area at least as a transient area since a bald eagle nest is located southeast of the survey area on Pen Branch about 1 mile away from the KAB.

Assessment endpoints are tailored to groups of organisms with similar feeding strategies and/or exposure scenarios appropriate to the remaining coal ash and coal fines OUs. Based on these considerations, the following assessment and measurement endpoints and their representative receptors were selected as discussed below.

- Protection of soil-dwelling invertebrate communities to maintain species diversity and nutrient cycling. Soil-dwelling invertebrate communities are selected because they are ecologically important, are susceptible to constituents in soil, and may be exposed at the remaining coal ash and coal fines OUs. The soil-dwelling invertebrate community is essential for decomposition of detritus, for energy and nutrient cycling, and for providing 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.

- 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 they are susceptible to soil constituents within the remaining coal ash and coal fines OUs. Cottontails 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. The measurement endpoint is a comparison of the measured constituent concentration to receptor-specific toxicity benchmarks.

- 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 remaining coal ash and coal fines OUs. 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. The measurement endpoint is a comparison of the measured constituent concentration to receptor-specific toxicity benchmarks.

- 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 units. The deer mouse was chosen as the representative receptor because of its omnivorous food habits. This receptor also represents 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. The measurement endpoint is a comparison of the measured constituent concentration to receptor-specific toxicity benchmarks.

- 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. The measurement endpoint is a comparison of the measured constituent concentration to receptor-specific toxicity benchmarks.

- 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. The measurement endpoint is a comparison of the measured constituent concentration to receptor-specific toxicity benchmarks.

- 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 gray 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. The measurement endpoint is a comparison of the measured constituent concentration to receptor-specific toxicity benchmarks.

The preliminary CSMs for the remaining coal ash and coal fines OUs are provided in Section 1.2.5. Data used in this evaluation, from samples collected from the HAB, KAB, and LAB, and also applied to FAL, are provided in Appendix A of this document.

D-1.4 Sources of Literature-Based Thresholds

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 potential contaminants based on No Observed Adverse Effect Level (NOAEL) and Low Observed Adverse Effect Level (LOAEL) thresholds. The ecological screening values (ESVs) are used in the initial screening-level effects evaluation and are based on NOAEL thresholds. For constituents that exceed ESVs and background screening, refinement screening values (RSVs) are used for the refinement-level risk calculation. The RSVs are based on LOAEL thresholds appropriate for refinement of soil medium constituents.

The threshold values used for the ESV and RSV assessments were derived from two sources: 1) the U.S. Environmental Protection Agency (USEPA) Region 4 Ecological Risk Assessment Supplement Guidance March 2018 Update (USEPA 2018); and 2) the Los Alamos National Laboratory (LANL) ECORISK Database Tool (LANL 2022). A brief discussion of the hierarchy of values and generic methodology used to derive values in these sources is as follows:

- The USEPA Region 4 Ecological Risk Assessment Supplement Guidance March 2018 Update (USEPA 2018) provides threshold values for hazardous waste sites for soils (Table 3) for non-radiological constituents and is provided in Attachment D-1.
    - The soil screening values in Table 3 typically address toxicity through direct exposure (i.e., toxicity to soil invertebrates such as earthworms, plants, and wildlife). The hierarchy for soil benchmarks is as follows: USEPA Ecological Screening levels (ESLs), U.S. Department of Energy laboratories (i.e., LANL and Oak Ridge National Laboratory), and equilibrium partitioning modeled values for organic chemicals.

- LANL developed the ECORISK Database Tool (LANL 2022) to document and archive ESLs. The LANL database tool includes thresholds for soil. LANL develops literature-based toxicity reference values (TRVs) for various chemical exposure pathways. Using the derived TRVs as well as dose rates (for radionuclides) and other benchmarks, LANL calculated No Effect and Low Effect ESLs for various media and receptors. The ECORISK Database Tool compiles the

resulting No Effect and Low Effect ESLs by media (surface water, sediment, soil) and receptor. The minimum ESL available from all receptors for a given media and constituent was used as the threshold level as follows: the minimum No Effect ESL was used as the threshold for the screening level assessment, and the minimum Low Effect ESL was used as the threshold for the refinement level assessment. The LANL screening values for the soil medium are provided in Attachment D-2 of this appendix.

The screening values derived from these sources are compared in the tables that are presented in Attachment D-3. All ESVs for a given constituent are identified by source, with the most conservative (i.e., lowest selected screening value) highlighted in yellow. The tables are as follows:

- Table I.A. SOIL MEDIA Screening Level (No Effect Screening Level)
  - The source of the "EPA R4 Soil" column is the Screening Level column from EPA Table 3 for soils (Attachment D-1).
  - The source of the "LANL Soil" column is the LANL ECORISK Database No Effect ESL for soil from (Attachment D-2).
- Table I.B. SOIL MEDIA Refinement Level (Low Effect Screening Level)
  - There are no EPA Region 4 RSV values for soil, so "NA" is listed under "EPA R4 Soil."
  - The source of the "LANL Soil" column is the ECORISK Database table of No Effects ESL for soil (Attachment D-3).
  - The source of the "LANL Soil" column is the Low Effect ESL for soil from Attachment D-2 LANL ECORISK Database table of No Effects ESLs and Low Effects ESLs.

D-2. ECOLOGICAL RISK ASSESSMENT PROCESS

This ERA consists of steps designed to provide a scientifically based and defensible assessment of exposure and hazard assessment for ecological receptors that will support a risk management decision regarding beneficial reuse of ash units. The ERA includes a screening-level ecological effects evaluation (Section D.2.1) in which constituent concentrations in surface soil media are compared to relevant ESLs; constituents that exceed ESVs, or that have no ESV, are considered

contaminants of potential ecological concern (COPECs). Frequency of detection is also considered during the ESV screening step. COPECs that result from the screening-level evaluation are carried forward to a refinement-level risk (hazard) calculation (Section D.2.2) in which refinement level HQs are calculated for each COPEC based on LOAEL or chronic level thresholds and the 95% UCL on the mean. Constituents that fail the refinement level screening are considered constituents of potential concern (COPCs). Uncertainties associated with the screening thresholds, background concentrations, nature and extent of contamination, age of data, or contaminants that result from the screening and refinement processes are discussed in an uncertainty evaluation presented in Section D.2.3. The uncertainty discussion concludes with a determination of whether the constituent should or should not be considered an RCOC. If RCOCs are identified, final action consideration is warranted.

The FAL, HAB, KAB, and LAB OUs risk screening process is discussed beginning in Section D-2.1 and continues through Section D-2.4. The AAP and ACPRB has already undergone an approved ERA (SRNS 2012). The AAP and ACPRB OU will undergo a refinement of RCOC discussion based on current environmental conditions in Section D-2.4 where all the remaining coal ash and coal fines units are discussed in terms of the refinement of RCOCs and results.

D-2.1 Screening-Level Effects Evaluation

The purpose of the ecological screening-level effects evaluation is to conduct a conservative screen to identify FAL, HAB, KAB, and LAB OU constituents that may pose unacceptable risk to ecological receptors. The screening level evaluation is the initial step in determining constituents that require further evaluation. Screening is conducted by comparing the maximum concentration to the ESVs found in Attachment D-3, Table I.A, and to two times the average SRS background level for the soil medium. The background data used in the screening-level effects evaluation for soil are taken from *Background Soils Statistical Summary Report for the Savannah River Site* (WSRC 2006). The report provides statistical summaries for many naturally occurring constituents at SRS. The maximum and data summary statistical values for each constituent with detected results for each subunit are presented in Appendix A.

Since maximum media concentrations are used in this step of the process, the assumption is made that ecological receptors are exposed to the highest (i.e., worst-case) concentration of a given constituent present at the unit. The combination of maximum media concentrations and conservative threshold values provide confidence that the COPCs resulting from the screenings are indeed protective.

Constituents that are recognized as essential nutrients (calcium, magnesium, potassium, and sodium) are identified as such and are not subject to further evaluation. These constituents are deemed necessary for life processes, therefore, consumption from natural sources is deemed not to be detrimental.

The ecological effects evaluation identifies the potential for adverse ecological effects based on conservative assumptions. The most conservative value (i.e., lowest concentration) between the EPA Region 4 and the NOAEL-based LANL values are used to conduct the screening level assessment.

The screening level evaluation process is outlined below:

- Compare the unit maximum detected concentration to the ESV concentration (No Effect Screening Level) for the surface interval (0 to 0.3 m [0 to 1 ft]) and calculate a screening level hazard quotient (HQ) for the surface interval. Calculation of the HQ is illustrated in the equation below:

$$HQ = Maximum\ Detected\ Concentration/NOAEL - based\ ESV$$

- Compare the unit maximum concentration of the naturally occurring (non-anthropogenic) constituents to two times the average SRS background concentration (WSRC 2006)

- Constituents exceeding the ESV (HQ >1), or with no ESV, and exceeding the background screen, are identified as COPECs and are carried forward. Constituents that are not identified as COPECs are dropped from further evaluation.

The table summarizing the ecological screening-level effects evaluation for the FAL, HAB, KAB and LAB OUs is provided in Table D-1 (for soil, 0 to 0.3 m [0 to 1 ft] interval)

The refinement process is discussed below in Section D.2.2.

D-2.2 Refinement-Level Risk (Hazard) Calculation

The refinement evaluation uses a comparison against the RSVs found in Attachment D-3, Table I.B. Because of the conservative approach of the initial screening 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 based on comparison to RSV-level ecological thresholds. The refined screening process applies a more realistic approach to screening to further refine the list to those constituents that require further evaluation for the FAH, HAB, KAB, and LAB OUs. The method used to further refine ecological COPCs is based on the calculation of a refinement-level HQ by comparing the Exposure Point Concentration (EPC) to a LOAEL 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:

$$HQ = EPC/LOAEL - based\ RSV$$

Constituents with an HQ >1 are further discussed in Section D-2.3.

For the COPECs identified in Section D.2.1, the refinement level process is outlined below:

- Calculate a refinement level HQ using the EPC and RSV (LOAEL-based ESL) comparison.
- Constituents with refinement levels HQ > 1, or with no RSV, are identified as COPCs and are carried forward to Section D.2.3. Constituents that are not identified as COPCs are dropped from further evaluation.

Table D-2 summarizes the ecological refinement-level effects evaluation for the FAL, HAB, KAB, and LAB OUs for the 0 to 0.3 m [0 to 1 ft] soil interval.

D-2.3 Identification of Constituents of Potential Concern for the Soil Medium

Uncertainties associated with the screening thresholds, background concentrations, nature and extent of contamination, age of data, or contaminants that result from the screening and refinement

processes are discussed in an uncertainty evaluation. The uncertainty discussion concludes with a determination of whether the constituent is considered an RCOC. The major categories of uncertainty used in this evaluation and the major emphasis include the following:

- Unit-related uncertainty, which includes uncertainties related to the nature and extent of contamination, consistency with history of use, and presence in background;
- Data quality uncertainty and risk assessment uncertainties, which include uncertainties related to data quality and physical characteristics;
- Risk assessment uncertainty, which includes uncertainties related to toxicity data and changes in constituent activity concentrations due to radioactive decay.

There is uncertainty associated with the screening thresholds, ESVs and TRVs, used in this ERA because the toxicity data are not unit specific. There are also limitations in toxicity values from the established sources used that may not include variations in physiological or biochemical factors that may influence the risk among species, behavioral and ecological parameters that may make a species' sensitivity to a contaminant different from that of the test organism, limited information on long-term effects on natural populations, or the exposure of the receptors based on contaminant distribution within the landscape in relation to the receptors' movement/exposure within the landscape. In addition, the ERA estimates the risk to populations of ecological receptors from individual contaminants and although cumulative risk is possible with exposure to multiple contaminants simultaneously, these effects are not addressed and can be antagonistic or synergistic resulting in differing threats from exposure. Finally, the lack of toxicity thresholds adds to the uncertainty of assessing risk. If an ESV/TRV is not available, there is uncertainty in assessing the risk to receptors because of the lack of thresholds from which to compare and is documented in the lines of evidence presented in the uncertainty discussion. These uncertainties may under- or over-represent the risk to receptors, but the ERA presented herein follows the currently accepted approach and methodologies to assessing risk to support informed management decisions for the Remaining Coal Ash/Coal Fines OUs.

In the uncertainty evaluation, exposure area concentrations are compared to background concentrations as one line of evidence to assist in the identification of RCOCs. The primary source of background information/data is provided below:

- *Background Soils Statistical Summary Report for the Savannah River Site* (WSRC 2006) provides statistical summaries for many naturally occurring constituents at SRS. The all-depth interval is the primary source of information used in this evaluation.

As an additional line of evidence, toxicity uncertainty is addressed for radionuclides with no available ESLs by comparing unit activity concentrations to Tier 3 Biota Concentration Guides (BCGs) found in the RESidual RADioactivity (RESRAD) BIOTA database (DOE 2004). The RESRAD Tier 3 values were generated by Savannah River National Laboratory based on the most conservative activity for each nuclide available for terrestrial systems (terrestrial animals and terrestrial plants) and aquatic systems (aquatic animals and riparian animals) (SRNL 2018). The Tier 3 values are provided in Attachment D-5.

In this ERA, average unit concentrations are given more significance than maximum concentrations since the wildlife receptors under consideration are not sedentary and their exposure is over a larger area than that encountered at a single sampling location. The exception to the assumption of non-sedentary behavior are soil invertebrates (i.e., earthworm). However, this is offset by the fact that the soil invertebrate endpoint is established at the community-level, and effects caused by a maximum concentration at a single location would not cause community-level impacts.

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 receptor-specific ESVs are provided in Attachment D-6. The PAUF is calculated based on the

ratio of the subunit area to the known home range of the receptor (Mirenda 2012) to reflect the fact that some receptors utilize an area beyond the contaminated site.

Calculated AUFs are provided in Attachment D-7 presenting the derivation of AUF and PAUF based on receptor home range and unit size. For the remaining coal ash and coal fines OUs, a surrogate unit size is used to maximize the exposure of the receptor, maximizing the overlap of home range with the size of the unit. This is a conservative estimate using the size of largest unit, the HAB OU (~ 5.3 ha [13.1 ac]) including the estimated ash, ~ 7.3 ha (18.4 ac), exterior to the basin to represent the size of the FAL, HAB, KAB, LAB OUs. The PAUF-adjusted-HQs is also based on mean concentrations to support the uncertainty discussion as presented in Attachment D-8.

D-2.3.1 Screening Results for the Soil Medium for the FAL, HAB, KAB, and LAB OUs

Using maximum detected values, Table D-1 identifies the following constituents as COPECs based on ESV screening for the 0 to 0.3 m (0 to 1 ft) soil interval: aluminum, arsenic, barium, beryllium, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, di-n-butylphthalate, actinium-228, bismuth-212, bismuth-214, lead-212, lead-214, potassium-40, radium-226, and thallium-208. Of those, the following constituents are considered COPECs since screening thresholds are not available: aluminum, iron, actinium-228, bismuth-214, bismuth-214, lead-212, lead-214, potassium-40, radium-226, and thallium-208.

D-2.3.2 Refinement Results for the Soil Medium for the FAL, HAB, KAB, and LAB OUs

Using EPC values (i.e., 95% UCL on the mean), Table D-2 identifies the following constituents as COPCs based on RSV screening in the 0 to 0.3 m (0 to 1 ft) soil interval: arsenic, selenium, and vanadium. The following constituents are also considered COPCs since RSV thresholds are not available: aluminum, di-n-butylphthalate, iron, actinium-228 bismuth-212, bismuth-214, lead-212, lead-214, potassium-40, and thallium-208.

It is the intent of the ERA to compile and assess risk based on regulatory accepted established thresholds. However, there are constituents that do not have an ERA threshold from which to compare, and this is an inherent uncertainty within the established risk assessment process.

D-2.3.3 Uncertainty Discussion for the Soil Medium for the FAL, HAB, KAB, and LAB OUs

An uncertainty analysis was performed for each COPC below, including an interpretive discussion of the lines of evidence and applicable uncertainty factors resulting in a recommendation on whether the constituent should be considered an RCOC. HQ calculations for receptors that pertain to RSV exceedances from Section D-2.3.2 are referred to in this discussion and can be found in Table D-2 for the 0 to 0.3 m (0 to 1 ft) interval for the soil medium. The uncertainty table is presented in Attachment D-4 showing calculated receptor-specific HQs for the soil medium. Calculated AUFs are provided in Attachment D-7, and PAUF-adjusted HQ calculations are shown in Attachment D-8.

Aluminum was detected in nine of nine samples with no J-qualified (estimated) results. The maximum was 21,600 mg/kg from the LASH-001 location in 2020. The detected mean was 7,082 mg/kg, and the EPC was 10,716 mg/kg. The mean (7,082 mg/kg) is less than the 2-times average SRS background 13,394 mg/kg and less than the maximum background level from all depths (23,700 mg/kg) (WSRC 2006). Aluminum is naturally occurring. There is no RSV for aluminum.

Aluminum is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no ecological RSV for aluminum.
- Aluminum is naturally occurring.
- The mean is less than SRS background.

Arsenic was detected in nine of nine samples with no J-qualified results. The maximum was 76.5 mg/kg from the HASH-002 location in 2020. The detected mean was 25.19 mg/kg, and the EPC was 37.61 mg/kg. The 2x average SRS background for arsenic is 4.28 mg/kg, and the maximum from all depths is 22.9 mg/kg.

The uncertainty evaluation (Attachment D-4, Table 1) shows HQ results for the American kestrel (Avian top carnivore) (HQ = 5.08E-03), American kestrel (insectivore/carnivore) (HQ = 3.7E-02), American robin (avian herbivore) (HQ = 1.11E-01), American robin (avian insectivore) (HQ = 2.51E-01), American robin (avian omnivore) (HQ = 1.79E-01), deer mouse (mammalian

omnivore) (HQ = 7.37E-01), earthworm (soil-dwelling invertebrate) (HQ = 5.53E-01), gray fox (mammalian top carnivore) (HQ = 2.89E-02), and mountain cottontail (mammalian herbivore) (HQ = 2.09E-01) are all less than 1.0 using a protective AUF set to 1, indicating the animal receives all of its exposure from the contaminated site. The montane shrew (mammalian insectivore) was the only receptor with a HQ > 1.0 (HQ = 1.21E+00).

When the AUF is adjusted to a unit-specific PAUF (based on home range and unit size) (Mirenda 2012) and the mean concentration is used, the PAUF-adjusted HQ results with an HQ > 1.0 is the deer mouse (HQ = 2.09E+00). The other receptors have HQs < 1.0 as shown in Attachment D-8. The unit mean concentration for arsenic (25.19 mg/kg) (Appendix A) is greater than 2x average SRS background for the 0 to 0.3 m (0 to 1 ft) interval is greater than the maximum SRS background (22.9 mg/kg).

Arsenic is recommended for further evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- The unit mean and maximum concentrations are greater than SRS background.
- The PAUF-adjusted HQ for the deer mouse is > 1.0.

Iron was detected in nine of nine samples with no J-qualified results. The maximum was 21,600 mg/kg, with a mean of 9,918 mg/kg and an EPC of 13,031 mg/kg. There is no RSV for iron. Iron is naturally occurring. The maximum all-depths value for SRS background for iron is 44,300 mg/kg, and the average background is 11,001 mg/kg. The mean for the remaining coal ash and coal fines OUs (9.918 mg/kg) is less than the average background.

Iron is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no ecological RSV for iron.
- Iron is naturally occurring.
- The mean is less than average and 2x average background.
- The EPC concentration is less than maximum background.

Selenium was detected in nine of nine samples. All results were J-qualified. The unit maximum, detected at the LASH-005 location in 2020, was 3.09 mg/kg with a mean of 2.21 mg/kg. The EPC was 2.59 mg/kg. The RSV, 1.0 mg/kg, is greater than the mean. The average background concentration is 1.5 mg/kg, with a 2x average SRS background concentration of 2.99 mg/kg. The unit mean (2.21 mg/kg) is less than 2x average SRS background. The maximum (3.09 mg/kg) is less than the maximum background (all depths) of 12.20 mg/kg.

The uncertainty evaluation (Attachment D-4, Table 1) shows HQs > 1.0 for the American robin (avian herbivore) (HQ = 1.36E+00), the American robin (avian insectivore) (HQ = 1.85E+00), American robin (avian omnivore) (HQ = 1.62E+00), Deer mouse (mammalian omnivore) (HQ = 2.16E+00), and Montane shrew (mammalian insectivore) (HQ = 2.59E+00) (Attachment D-4).

When the AUF is adjusted to a unit-specific PAUF (based on home range and unit size) (Mirenda 2012) using the mean concentrations, HQs > 1.0 include the American robin (avian insectivore) (HQ = 1.19E+00), American robin (avian omnivore) (HQ = 1.05E+00), deer mouse (mammalian omnivore) (HQ = 1.05E+00), and montane shrew (mammalian insectivore) (HQ = 1.80E+00). The other receptors shown in Attachment D-8 for selenium have HQs < 1.0.

Selenium is not recommended for further evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- Selenium is naturally occurring.
- The unit mean is less than 2x average background.
- The unit maximum is less than the maximum background (all depths).

Vanadium was detected in nine of nine samples with no J-qualified results. The maximum was 48.8 mg/kg at the LASH-001 location in 2020. The EPC was 32.95 mg/kg. The unit mean is 25.64 mg/kg. The RSV is 9.5 mg/kg. The 2x average SRS background concentration is 39.1 mg/kg, which is greater than the unit mean. The unit maximum (48.8 mg/kg) is also less than the maximum background (all depths) of 104.00 mg/kg and less than the maximum background for the 0 to 0.3 m (0 to 1 ft) interval (66.80 mg/kg).

The uncertainty evaluation (Attachment D-4, Table 1) shows HQs > 1.0 for the American robin (avian herbivore) (HQ = 2.53E+00), the American robin (avian insectivore) (HQ = 3.47E+00), American robin (avian omnivore) (HQ = 3.00E+00).

When the AUF is adjusted to a unit-specific PAUF (based on home range and unit size) using the mean concentrations, HQs > 1.0 include the American robin (avian herbivore) (HQ = 1.49E+00), American robin (avian insectivore) (HQ = 2.04E+00) and American robin (avian omnivore) (HQ = 1.76E+00).

Vanadium is not recommended for further evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- Vanadium is naturally occurring.
- Two-times average background concentration is less than the unit mean.
- The unit maximum is also less than the maximum background.

Actinium-228 was detected in nine of nine samples with no J-qualified results. The maximum was 4.15 picocuries per gram (pCi/g) from the HASH-002 location in 2020. The mean was 2.51 pCi/g, and the EPC was 2.99 pCi/g. Actinium-228 came through screening because there is no RSV available.

Actinium-228 is naturally occurring, and the maximum detected concentration associated with the remaining coal ash and coal fines OUs is within background levels. The mean was 2.51 pCi/g. The SRS maximum background activity is 2.54 pCi/g, and the SRS 2x average background activity is 1.95 pCi/g.

Actinium-228 is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no screening threshold available.
- It is a naturally occurring radionuclide.
- The unit mean is less than SRS maximum background.

Bismuth-212 was detected in nine of nine samples with seven results J-qualified. The maximum detected concentration was 4.23 pCi/g at the HASH-002 location in 2020. The mean detected concentration was 2.873 pCi/g and the EPC was 3.418 pCi/g. Bismuth-212 came through screening because there is no RSV available. The half-life for bismuth-212 is 2.0 minutes.

Bismuth-212 is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no screening threshold available.
- It has a short physical radiological half-life.

Bismuth-214 was detected in nine of nine samples with no J-qualified results. The maximum was 5.57 pCi/g from the LASH-001 location in 2020. The mean was 2.973 pCi/g, and the EPC was 3.792 pCi/g. Bismuth-214 came through screening because there is no RSV available. Also, bismuth-214 is naturally occurring. Although bismuth-214 is naturally occurring, the maximum SRS background (all depths) is 1.740 pCi/g. The physical radiological half-life is 19 minutes.

Bismuth-214 is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no screening threshold available.
- It has a short radiological half-life.

Lead-212 was detected in nine of nine samples with no J-qualified results. The maximum detected concentration was 3.55 pCi/g at the HASH-002 location in 2020. The mean detected concentration was 2.334 pCi/g, and the EPC was 2.78 pCi/g. Lead-212 came through screening because there is no RSV available. Lead-212 is naturally occurring, and the half-life is short at 10.6 hours. The maximum SRS background for lead-212 (for all depths) is 2.79 pCi/g, which is just below the EPC (2.78 pCi/g).

Lead-212 is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no screening threshold available.

- It is a naturally occurring radionuclide.
- The mean and EPC are less than SRS maximum background concentrations.
- It has a short half-life.

Lead-214 was detected in nine of nine samples. The maximum detected concentration was 6.26 pCi/g at the LASH-001 location in 2020. The mean detected concentration was 3.411 pCi/g, and the EPC was 4.377 pCi/g. Lead-214 came through screening because there is no RSV available. The half-life lead-214 is 26.81 minutes.

Lead-214 is not recommended for further remedial evaluation as an ecological RCOC in subsurface soil based on the following lines of evidence:

- There is no screening threshold available.
- It has a short half-life.

Potassium-40 was detected in nine of nine samples. The maximum detected concentration was 12.5 pCi/g at the KASH-005 location in 2020. The mean detected concentration was 9.197 pCi/g, and the EPC was 11.16 pCi/g. Potassium-40 came through screening because there is no RSV available. Potassium-40 is naturally occurring. The maximum detected activity (12.5 pCi/g) is below the RESRAD Biota screening value of 119 pCi/g (Attachment D-5).

Potassium-40 is not recommended for further remedial evaluation as an ecological RCOC in surface soil based on the following lines of evidence:

- There is no screening threshold available.
- It is a naturally occurring radionuclide.
- It is well below the RESRAD Biota level.

Thallium-208 was detected in nine of nine samples. None of the detected samples were J-qualified. The maximum detected concentration was 1.04 pCi/g at the HASH-002 location in 2020. The mean detected concentration was 0.682 pCi/g and the EPC was 0.824 pCi/g. Thallium-208 came through screening because there is no RSV available. The half-life of thallium-208 is 3.05 minutes.

Thallium-208 is not recommended for further remedial evaluation as an ecological RCOC in subsurface soil based on the following lines of evidence:

- There is no screening threshold available.
- It has a short half-life.

D-2.3.4 AAP and ACPRB OU – Soil Medium

For the AAP and ACPRB OU, the RFI/RI Work Plan and RFI/RI/BRA/CMS/FS (SRNS 2012) documented the results of the ERA for these two units. The RFI/RI BRA identified no ecological RCOCs for the surface (0 to 0.3 m [0 to 1 ft] or subsurface (0.3 to 1.2 m [1 to 4 ft] interval for the soil medium for the AAP.

For the ACPRB (SRNS 2012), arsenic and 2-methylnaphthalane were identified as RCOCs for surface (0 to 0.3 m [0 to 1 ft]) sediment/coal fines medium (HQ = 2.5 for each constituent). In addition, pH was identified as an ecological RCOC for benthic-dwelling organisms for sediment. For surface water, aluminum (HQ = 25), barium (HQ = 34), beryllium (HQ = 2.8), cadmium (HQ = 14), cobalt (HQ = 1.4), copper (HQ = 6), iron (HQ = 5.5), lead (HQ = 10), manganese (HQ = 3), nickel (HQ = 2.9), and zinc (HQ = 8.7) were identified as ecological RCOCs for aquatic receptors (surface water). In addition, pH also is identified as an ecological RCOC for aquatic organisms.

D-2.4 Refinement of RCOCs and Results

Based on the uncertainty evaluation presented in Section D-2.3.3, arsenic is the only constituent identified as an RCOC for the surface (0 to 0.3 m [0 to 1 ft]) interval for the soil medium for the FAL, HAB, KAB, and LAB OUs. The other constituents were ultimately screened out based on various lines of evidence including background comparisons, no screening threshold available for screening, short half-lives, and AUF/PAUF-adjusted HQs being below 1.0.

For the AAP and ACPRB OU (SRNS 2012), arsenic and 2-methylnaphthalane were identified as RCOCs for surface (0 to 0.3 m [0 to 1 ft]) sediment/coal fines medium. For the surface water medium, aluminum, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, nickel, and zinc were identified as ecological RCOCs for aquatic receptors due to the presence of surface water.

However, ecological data is the pillar of the ERA process. Threshold screening provides one level of evaluation, but site-specific ecological data, if available, determines if threshold exceedances may be eliciting adverse effects thereby negatively impacting ecological resources. SRS has a significant amount of historical information on ash waste units, and ecological data has been applied to SRS ash-related waste units to determine whether a constituent should (or should not) be carried through as a final ecological RCOC for remedial consideration.

Initial studies of ash waste units at the SRS were conducted primarily by the Savannah River Ecology Laboratory (SREL) and the Savannah River National Laboratory and included, but was not limited to, earthworm toxicity testing, trace element distribution and speciation, assessment of plant and animal communities, contaminant inventories, and body burden assessments.

Based on these initial studies, chronic exposure to contaminants associated with coal combustion wastes (CCW) became a focus of study by the SREL for the last several decades at SRS. Amphibians had been a primary focus of several efforts since amphibians are ideally suited for investigating chronic level affects due to their heightened skin permeability and contaminant susceptibility in both terrestrial and aquatic systems. Initial studies were conducted in D Area ash basins that served as aquatic habitat. Ecological investigation also included ash depositional environments, in particular, the D-Area Ash Basin Wetlands (DABW) and the Wetland Area at Dunbarton Bay (WADB). The DABW is a 36 ha (90 ac) ash plume that extends into the Savannah River floodplain adjacent to the Savannah River. The ash associated with the WADB included ash within a Carolina bay. Both of the ash depositional areas had historic deposition that ceased decades ago (>35 years).

For the WADB, SREL collected and analyzed both biotic and abiotic samples (SRNS 2013). The findings showed overall levels of arsenic, selenium, and strontium were elevated in Dunbarton Bay when compared to the reference Carolina bay, however, no population- level effects related to elevated body burdens were observed. The number of herpetofauna species in Dunbarton Bay were comparable to the nearby reference bay, indicating that the elevated contaminants are not adversely impacting the biodiversity of herpetofauna within Dunbarton Bay. The results indicate, overall, that the ash/soil media at Dunbarton Bay does not represent a significant risk to populations/communities of ecological receptors.

Following on the results of these initial studies and the ERA approach used for the approved *Focused Corrective Measures Study/Feasibility Study Report for the Wetland Area at Dunbarton Bay* (SRNS 2013), the SREL began a final investigation of the DABW in 2022. The study, *Bioaccumulation and Community Composition of Small Terrestrial Biota Exposed to Coal Combustion Residual Contaminants* (Holland, 2024), was completed in April 2024.

As expected, the ecological investigation found trace element concentrations were higher in ash-contaminated soils than reference soils. Target biota captured for body burden analyses had elevated levels of arsenic, selenium, and strontium when compared to reference samples. However, similar to the WADB investigation, evaluation of community-level metrics including species richness and diversity of small vertebrate species found communities within the ash depositional area were reflective of a typical southeastern floodplain forest. Collection of environmental abiotic data showed that parameters varied minimally among contaminated and reference sites. Elevation and ground cover differed between sites, but there was no evidence that differences affected species richness or diversity. Ground cover density was found to be greater at the ash sampling sites compared to the reference site, which may be attributed to the enriched availability of essential trace elements for plants growing within the ash plume area.

Overall, there was little evidence that the presence of ash-associated contaminants in DABW are impacting alpha diversity measures such as species richness and diversity. Findings suggest beta diversity, measured by dissimilarity in species composition, also provided no evidence of negative effects due to the broad overlap in species composition among reference and ash-contaminated sites.

Both depositional areas (DABW and WADB) are now revegetated with a mature mixed hardwood/floodplain community and an organic soil layer that has developed over time. Conditions within these ash depositional areas are similar to conditions at the remaining coal ash and coal fines OUs. Units that at one time served as active/operational ash basins are now forested habitat included within the ecological landscape.

The AAP and ACPRB OU is similar to the other remaining coal ash and coal fines OUs in that these units are no longer operational and have undergone secondary succession (Figure D-3). The RFI/RI Work Plan and RFI/RI Report with BRA (SRNS 2012) alluded to this future transformation

of the AAP and ACPRB OU with the collection of surface water from the basin, indicating that the during the second of two sampling events, only a small area of ponded water, approximately 6.1 by 6.1 m (20 by 20 ft) wide, remained. Elevated metals detected during August 2009 (the previous year sampling event) were described as likely the result of elevated turbidity, and the surface water constituents were conservatively retained as ecological RCOCs (SRSN 2012).

Currently, the ACPRB has recolonized with primarily an upland mature pine/hardwood habitat with little in the way of aquatic habitat. A field visit to the ACPRB was conducted on July 7, 2024, after an appreciable rain occurred several days prior. There was evidence of wet soils from two recent hog wallows, but no surface water and no wetland vegetation were observed. Volunteer pine trees were growing within the small depressional area, indicating that this previously pooled area is also transforming to a mature pine/hardwood habitat. The area that may previously, temporarily held water, current based on review of topography, aerial photography, and confirmed by the field walk-down in July 2024, is unlikely to provide much in the way of surface water and/or sediment exposure to aquatic or sediment-dwelling organisms due to the lack of adequate aquatic habitat within this successional forested ecosystem. The "marginal resources" referred to in the RFI/RI WP RFI/RI Report with BRA and CMS/FS for the AAP and ACPRB (SRNS 2012) is even less appreciable now considering the current conditions of the ACPRB (from marginal aquatic habitat to pine/hardwood forest). Therefore, there are no ecological RCOCs for surface water for the ACPRB.

The "marginal resources" for surface water described above also translate to the previously described sediment medium addressed in the RFI/RI WP RFI/RI Report with BRA and CMS/FS for the AAP and ACPRB (SRNS 2012). In similar fashion, the marginal resources are even less appreciable now considering ACPRB transition from a marginal aquatic habitat to a mature pine/hardwood forest. In addition, review of the sediment data presented in the RFI/RI Work Plan and RFI/RI Report with BRA (SRNS 2012) was conducted by comparing RSV thresholds for soil to mean levels reported from the ACPRB. Both arsenic (24 mg/kg) and 2-methylnapthalene (0.173 mg/kg), the two constituents identified as RCOCs in the BRA for sediment (SRNS 2012), are less than their respective RSVs (31 mg/kg and 160 mg/kg, respectively). As such, there are no RCOCs for the ACPRB (for soil) based on current conditions.

Following multiple lines-of-evidence is an appropriate and defensible approach to determining whether the SRS ash units have the potential to pose a significant risk to wildlife/ecological receptors. Overall, these lines-of-evidence have included chemical analysis of the impacted media, literature-based risk calculations, bioaccumulation with biota tissue assessments, and population/community surveys to make an assessment on the ecological health of ash units.

The results of these evaluations show no clear evidence that the SRS ash units, including WADB and DABW, negatively impacted ecological receptors. These recovered ecological systems appear to be healthy and diverse when compared to similar areas where ash is not present. Therefore, it is reasonable to assume that from an ecological risk perspective, there are no problems warranting action for the remaining historically operational ash units. As such, no RCOCs are identified for the remaining coal ash and coal fines OUs. Attachment D-9 includes a list of selected publications relating to the ecological studies conducted at SRS ash OUs.

D-3. SUMMARY/CONCLUSIONS OF ECOLOGICAL RISK ASSESSMENT

There are three possible decisions that can be made upon completion of the ERA:

- There are adequate data to conclude that ecological risks are negligible, therefore, there is no need for remediation on the basis of ecological risk;
- The information indicates adverse ecological effects and the need for remedial action is warranted; or
- The information is not adequate to make a decision at this point and the ERA process will continue to address data gaps.

The ecological assessment for the remaining coal ash and coal fines OUs indicates that the data are adequate to conclude that ecological risks are negligible, and additional information is not needed to make a remedial decision recommendation for the protection of ecological receptors. Site-specific ecological/biological studies have been conducted on various ash units at the SRS, primarily associated with ash depositional areas in sensitive environments such as Carolina bays (i.e., WADB) or a within floodplain habitat (i.e., DABW). The ecological investigations are the

final determining factor in assessing whether remedial action is required for the protection of ecological resources. These recolonized/recovered areas appear healthy and diverse as compared to similar uncontaminated areas, and it is reasonable to conclude that from an ecological perspective, the remaining coal ash and coal fines OUs offer similar habitat to surrounding areas. This can be expanded to include ash piles, basins, and the coal pile runoff basin, as these units have undergone secondary succession and have become integrated within the natural landscape over time.

The following table presents the overall summary of the ERA based on media. The revised CSMs for the remaining coal ash and coal fines OUs are presented in Section 1.2.5 and provided in Figures 16 – 21.

OU	ERA Soil 0 to 0.3 m (0 to 1 ft) RCOCs	ERA Sediment 0 to 0.3 m (0 to 1 ft) RCOCs	ERA Surface Water RCOCs
AAP	None	NA	NA
ACPRB	None	None	None
FAL, HAB, KAB, LAB	NA	None	NA

Additionally, from a long-term perspective, the remaining coal ash and coal fines OUs have been identified for future beneficial reuse. At the time of beneficial use, the intended final action for these units is clean closure after excavation of ash material for beneficial reuse, thereby negating any future potential ecological risk associated with these units as long as the current projection of beneficial reuse is maintained. The interim action for the remaining coal ash and coal fines OUs is to maintain the OUs *as is* until the time the ash is needed for future beneficial reuse unless environmental conditions change.

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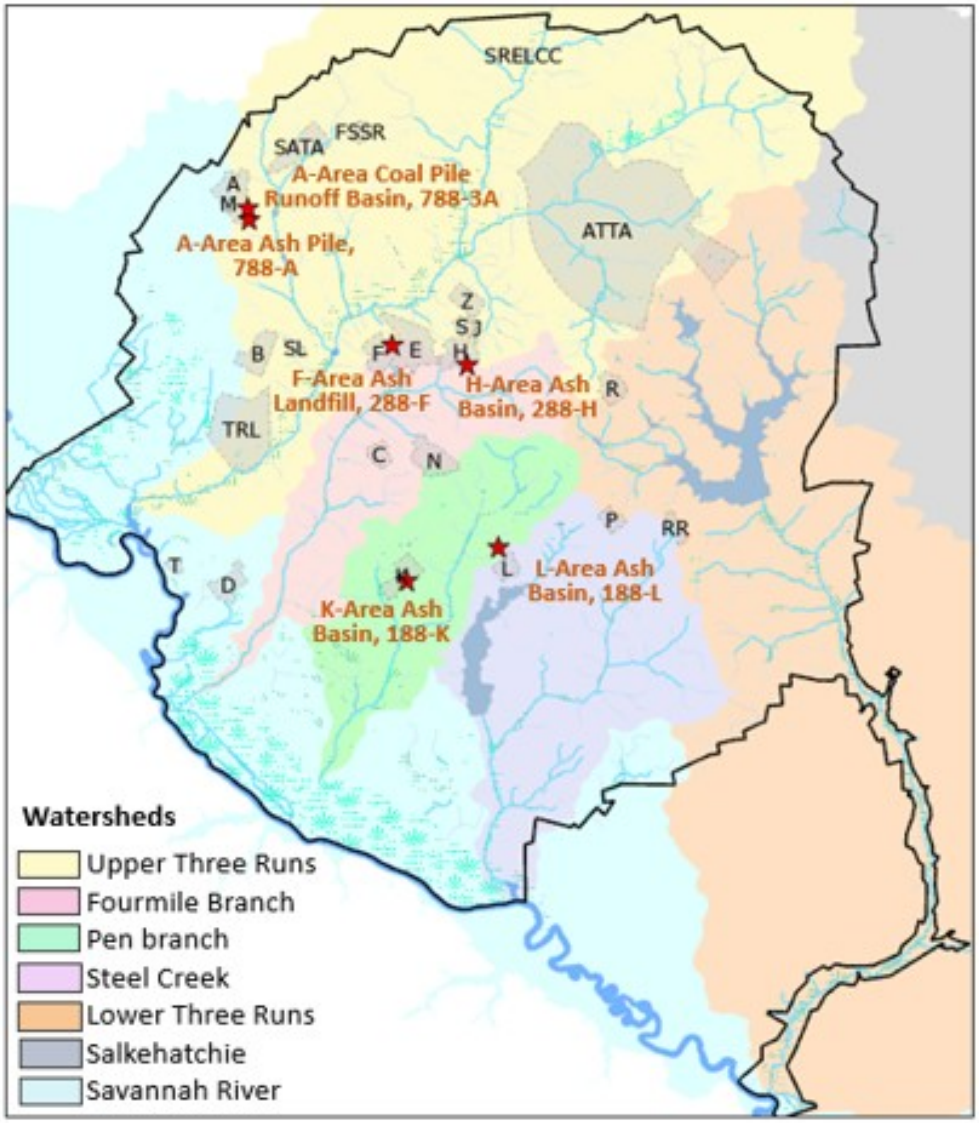


Figure D-1. Location of Remaining Coal Ash and Coals Fines Operable Units

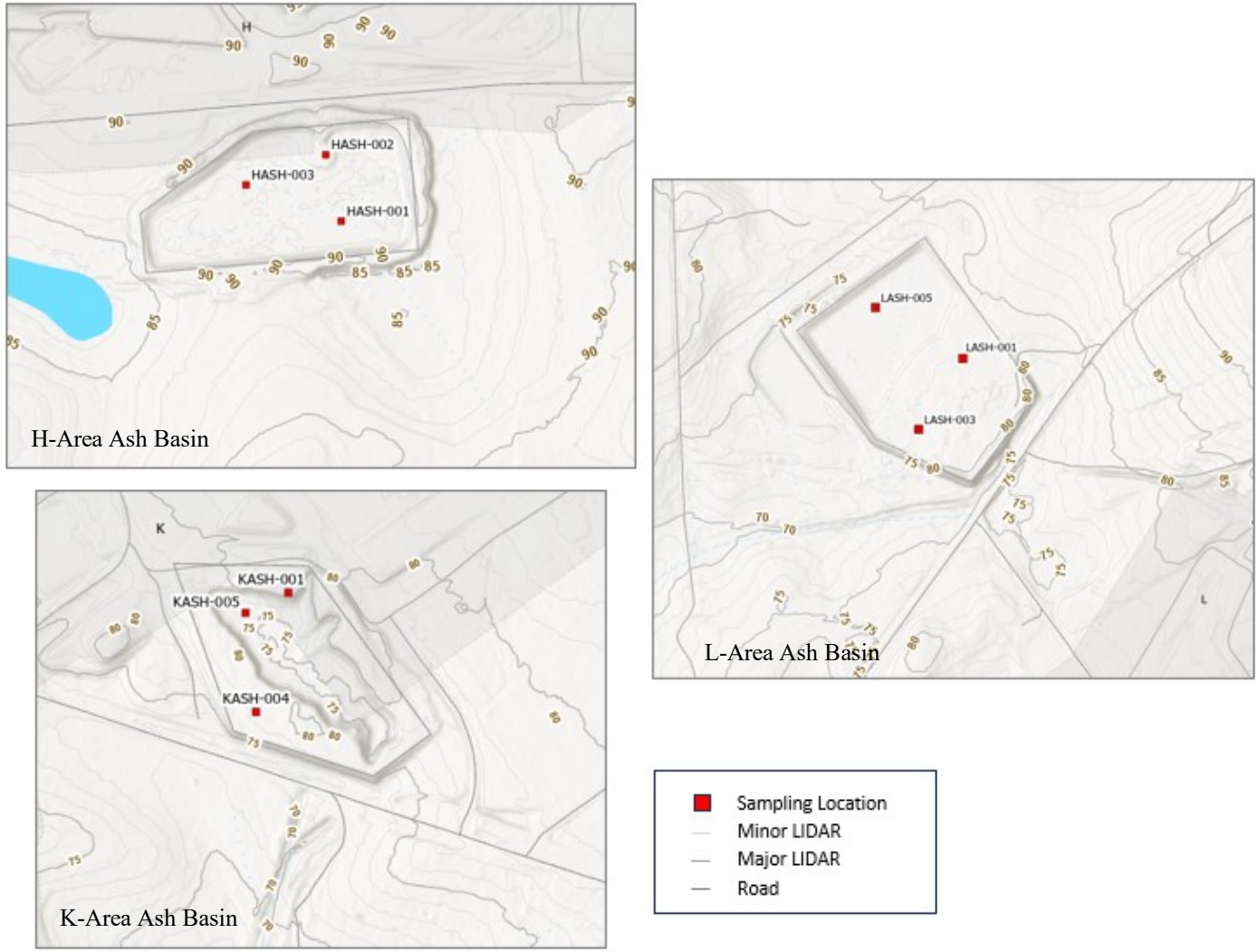


Figure D-2. Generalized Sample Location Map



Figure D-3. A-Area Coal Pile Runoff Basin and A-Area Ash Pile within the Landscape

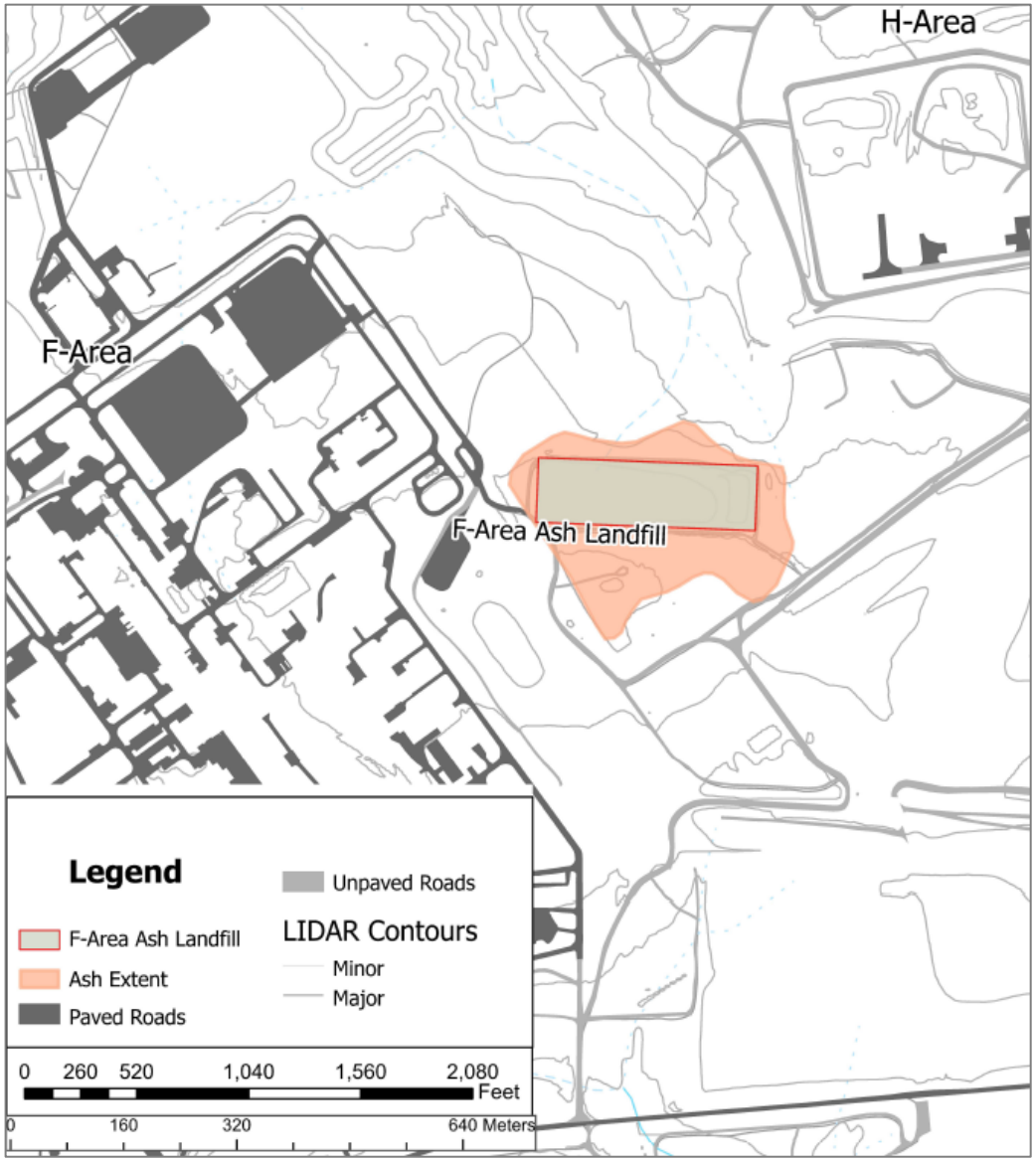


Figure D-4. F-Area Ash Landfill

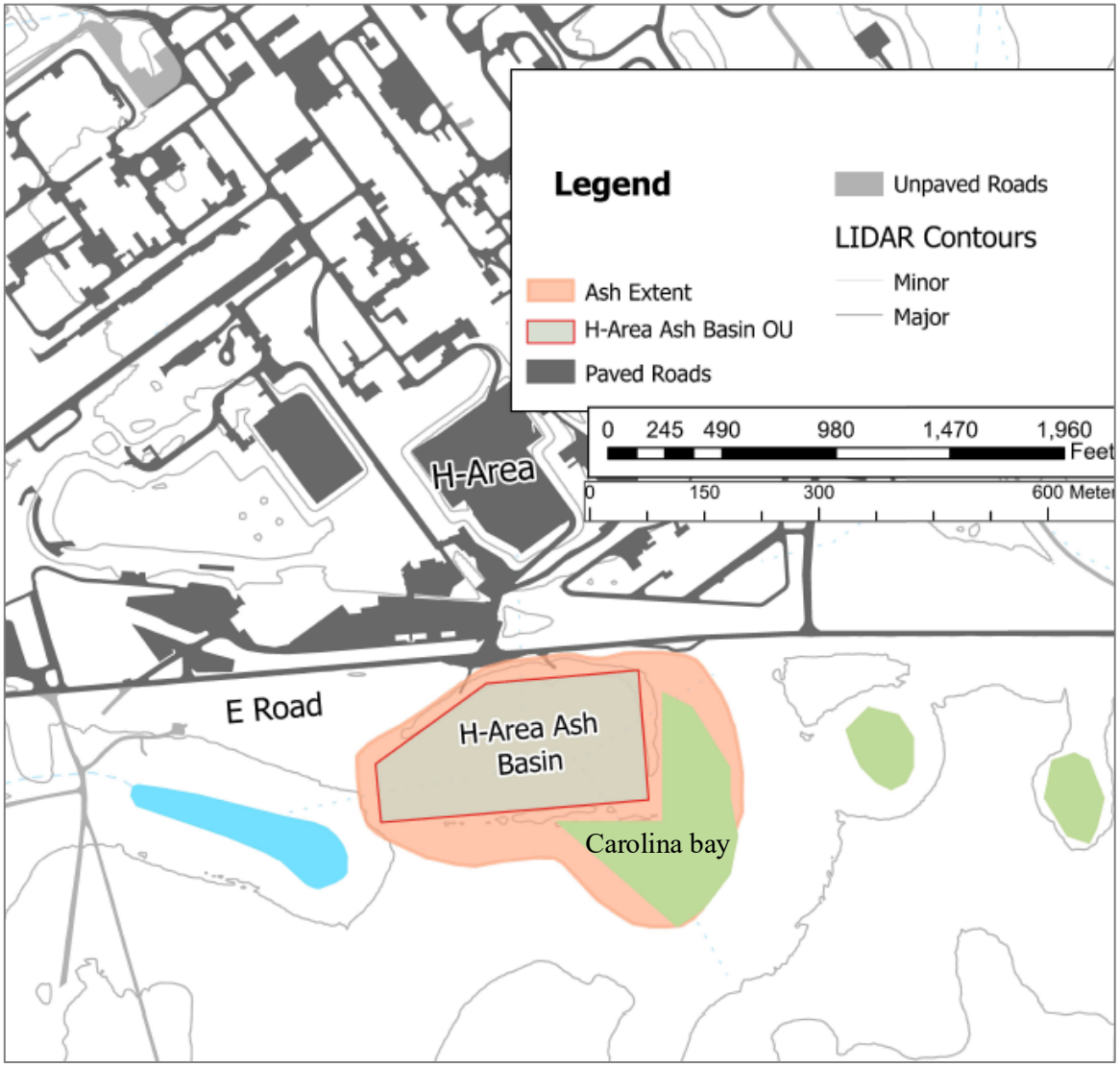


Figure D-5. H-Area Ash Basin

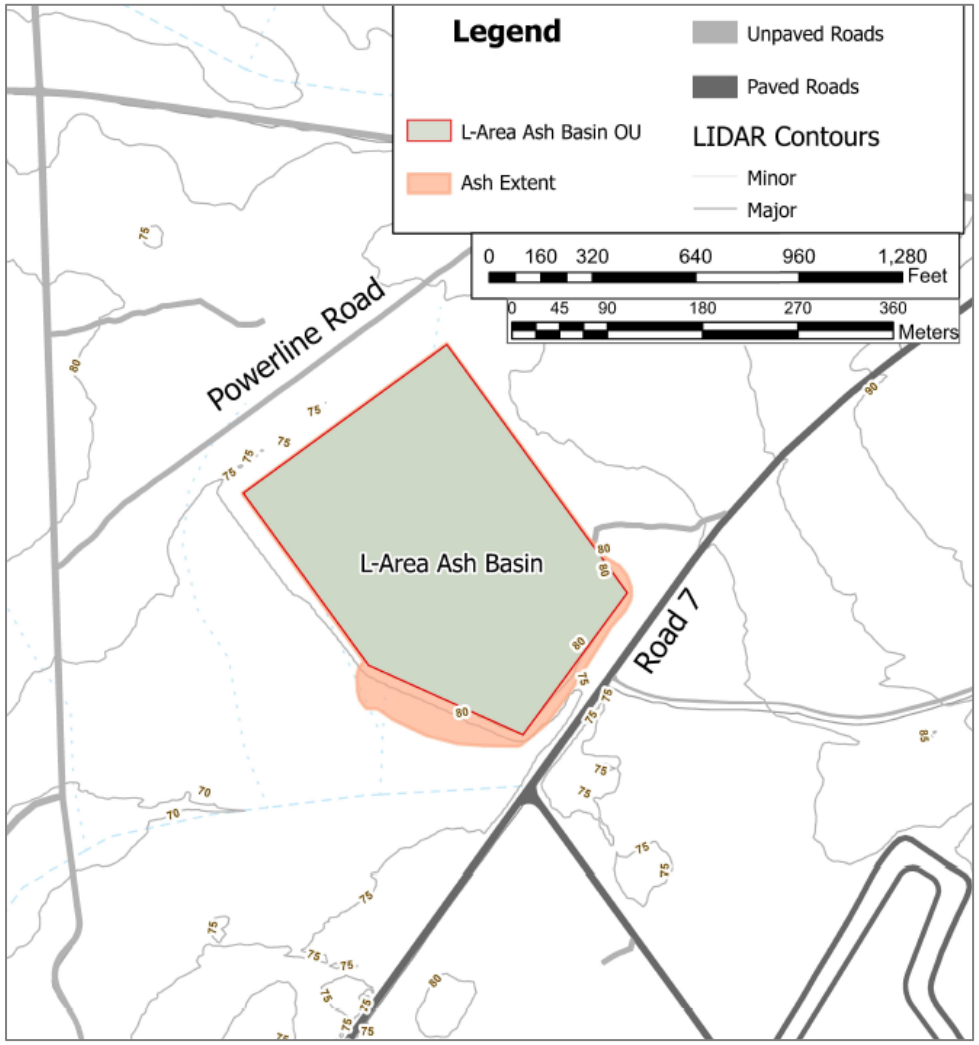


Figure D-6. K-Area Ash Basin **Figure D-7. L-Area Ash Basin**

Table D-1. Screening Level Evaluation for the HAB, FAL, KAB, and LAB OUs (Soil 0 to 0.3 m [0 to 1 ft])

Analyte	Detected Maximum Concentration[1]	Qualifier[2]	ESV[3]	ESV Source[4]	Screening Level HQ[5]	Maximum Exceeds ESV (HQ>1)?	2X Average Bkgrd[6]	Max > Bkgrd	COPEC?[7]
Inorganics (mg/kg)									
ALUMINUM	2.16E+04		NA	NA	NA	---	1.05E+04	YES	YES
ARSENIC	7.65E+01		6.80E+00	b	1.13E+01	YES	4.28E+00	YES	YES
BARIUM	4.79E+02		3.30E+02	a,b	1.45E+00	YES	3.91E+01	YES	YES
BERYLLIUM	5.06E+00		2.50E+00	a	2.02E+00	YES	2.88E-01	YES	YES
CALCIUM	4.59E+04		NA	Nutrient	NA	no	4.76E+02	YES	no
CHROMIUM	1.87E+01		2.30E+01	a,b	8.13E-01	no	1.54E+01	YES	no
COBALT	1.01E+01		1.30E+01	a	7.77E-01	no	1.55E+00	YES	no
COPPER	3.90E+01		1.40E+01	b	2.79E+00	YES	4.34E+00	YES	YES
IRON	2.16E+04		NA	NA	NA	---	1.27E+04	YES	YES
LEAD	1.25E+01		1.10E+01	a,b	1.14E+00	YES	1.03E+01	YES	YES
MAGNESIUM	5.44E+03		NA	Nutrient	NA	no	2.75E+02	YES	no
MANGANESE	2.30E+02		2.20E+02	a	1.05E+00	YES	1.53E+02	YES	YES
MERCURY	1.03E-01		1.30E-02	a,b	7.92E+00	YES	7.10E-02	YES	YES
NICKEL	1.55E+01		1.00E+01	b	1.55E+00	YES	3.48E+00	YES	YES
POTASSIUM	1.95E+03		NA	Nutrient	NA	no	2.16E+02	YES	no
SELENIUM	3.09E+00		5.20E-01	a	5.94E+00	YES	2.99E+00	YES	YES
SODIUM	5.92E+02		NA	Nutrient	NA	no	4.02E+01	YES	no
VANADIUM	4.88E+01		4.70E+00	b	1.04E+01	YES	3.91E+01	YES	YES
ZINC	2.67E+01		4.60E+01	a	5.80E-01	no	9.47E+00	YES	no

Table D-2. Screening Level Evaluation for the HAB, FAL, KAB, and LAB OUs (Soil 0 to 0.3 m [0 to 1 ft]) *(Continued)*

Analyte	Detected Maximum Concentration[1]	Qualifier[2]	ESV[3]	ESV Source[4]	Screening Level HQ[5]	Maximum Exceeds ESV (HQ>1)?	2X Average Bkgrd[6]	Max > Bkgrd	COPEC?[7]
Organics (mg/kg)									
2-METHYLNAPHTHALENE	4.15E-01		1.60E+01	b	2.59E-02	no	NA	---	no
BIS(2-ETHYLHEXYL)PHTHALATE	1.65E-02	J	2.00E-02	a, b	8.25E-01	no	NA	---	no
BENZO(G,H,I)PERYLENE	2.97E-02	J	1.10E+00	a	2.70E-02	no	NA	---	no
BENZO[A]ANTHRACENE	3.26E-02	J	7.30E-01	b	4.47E-02	no	NA	---	no
BENZO[A]PYRENE	1.52E-02	J	1.10E+00	a	1.38E-02	no	NA	---	no
BENZO[B]FLUORANTHENE	3.75E-02		1.10E+00	a	3.41E-02	no	NA	---	no
CHRYSENE	3.51E-02	J	1.10E+00	a	3.19E-02	no	NA	---	no
DI-N-BUTYLPHTHALATE	2.46E-02		1.10E-02	a, b	2.24E+00	no	NA	---	no
FLUORANTHENE	4.97E-02		1.10E+00	a	4.52E-02	no	NA	---	no
INDENO[1,2,3-CD]PYRENE	1.30E-02		1.10E+00	a	1.18E-02	no	NA	---	no
NAPHTHALENE	2.60E-01		3.40E+00	b	7.65E-02	no	NA	---	no
PHENANTHRENE	2.28E-01		5.50E+00	b	4.15E-02	no	NA	---	no
PYRENE	6.42E-02		1.10E+00	a	5.84E-02	no	NA	---	no
Radionuclides (pCi/g)									
ACTINIUM-228	4.15E+00		NA	NA	NA	---	1.95E+00	YES	YES
BISMUTH-212	4.23E+00		NA	NA	NA	---	NA	---	YES
BISMUTH-214	5.57E+00		NA	NA	NA	---	2.24E+00	YES	YES
CESIUM-137	2.26E-01		1.40E+03	b	1.61E-04	no	2.84E-01	no	no

Table D-3. Screening Level Evaluation for the HAB, FAL, KAB, and LAB OUs (Soil 0 to 0.3 m [0 to 1 ft]) *(Continued/End)*

Analyte	Detected Maximum Concentration[1]	Qualifier[2]	ESV[3]	ESV Source[4]	Screening Level HQ[5]	Maximum Exceeds ESV (HQ>1)?	2X Average Bkgrd[6]	Max > Bkgrd	COPEC?[7]
Radionuclides (pCi/g)									
LEAD-212	3.55E+00		NA	NA	NA	---	2.19E+00	YES	YES
LEAD-214	6.26E+00		NA	NA	NA	---	NA	---	YES
POTASSIUM-40	1.25E+01		NA	NA	NA	---	2.33E+00	YES	YES
RADIUM-226	8.63E+00		1.50E+00	b	5.75E+00	YES	1.37E+00	YES	YES
RADIUM-228	1.10E+00		1.20E+00	b	9.17E-01	no	1.92E+00	no	no
THALLIUM-208	1.04E+00		NA	NA	NA	---	NA	---	YES
THORIUM-228	4.27E+00		4.30E+01	b	9.93E-02	no	1.97E+00	YES	no
THORIUM-230	8.02E+00		5.20E+01	b	1.54E-01	no	1.13E+00	YES	no
THORIUM-232	3.90E+00		6.20E+00	b	6.29E-01	no	1.80E+00	YES	no
URANIUM-233/234	6.72E+00		2.20E+03	b	3.05E-03	no	1.15E+00	YES	no
URANIUM-235	5.61E-01	J	1.60E+03	b	3.51E-04	no	7.98E-02	YES	no
URANIUM-238	5.82E+00		1.10E+03	b	5.29E-03	no	1.01E+00	YES	no

1 - Maximum detected concentration from Appendix A, Table A-1 (0-1 ft)

2 - Maximum detected concentration qualifier from Appendix A, Table A-1 (0-1 ft)

3 - Ecological Screening Value (ESV) from Attachment D-3

4 - Source of ESV
a - Table 3, USEPA Region 4 Ecological Risk Assessment Supplemental Guidance, March 2018 Update
b - LANL No Effect ESL for soil media (LANL 2022)

5 - Screening Level Hazard Quotient (HQ) = maximum detected concentration / ESV

6 - Background screening values obtained from Background Soils Statistical Summary Report for the Savannah River Site (WSRC 2006). Values are listed in Appendix A, Table A-1 (0-1 ft interval)

7 - Constituent of Potential Ecological Concern (COPEC). Analyte identified as a COPEC if the maximum detected concentration exceeds the ESV (i.e., HQ>1)

Table D-4. Refinement Level Evaluation for the HAB, FAL, KAB, and LAB OUs (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]	EPC > RSV (HQ>1)	COPC?[6]
Inorganics (mg/kg)						
ALUMINUM	1.07E+04	---	NA	NC	---	YES
ARSENIC	3.76E+01	3.10E+01	b	1.21E+00	YES	YES
BARIUM	2.60E+02	1.20E+03	b	2.16E-01	no	no
BERYLLIUM	2.92E+00	3.50E+02	b	8.35E-03	no	no
COPPER	3.51E+01	4.30E+01	b	8.16E-01	no	no
IRON	1.30E+04	---	NA	NC	---	YES
LEAD	1.03E+01	2.30E+01	b	4.47E-01	no	no
MANGANESE	1.07E+02	2.70E+03	b	3.95E-02	no	no
MERCURY	7.39E-02	1.30E-01	b	5.68E-01	no	no
NICKEL	1.43E+01	2.10E+01	b	6.80E-01	no	no
SELENIUM	2.59E+00	1.00E+00	b	2.59E+00	YES	YES
VANADIUM	3.30E+01	9.50E+00	b	3.47E+00	YES	YES
Organics (mg/kg)						
DI-N-BUTYLPHTHALATE	2.46E-02	1.1E-01	b	2.24E-01	no	no
Radionuclides (pCi/g)						
ACTINIUM-228	2.99E+00	NA	NA	---	---	YES
BISMUTH-212	3.42E+00	NA	NA	---	---	YES
BISMUTH-214	3.79E+00	NA	NA	---	---	YES
LEAD-212	2.78E+00	NA	NA	---	---	YES
LEAD-214	4.38E+00	NA	NA	---	---	YES

Table D-2. Refinement Level Evaluation for the HAB, FAL, KAB, and LAB OUs (Soil 0 to 0.3 m [0 to 1 ft]) *(Continued/End)*

Analyte[1]	Exposure Point Concentration[2]	RSV[3]	RSV Source[4]	Refinement Level HQ[5]	EPC > RSV (HQ>1)	COPC?[6]
POTASSIUM-40	1.12E+01	---	NA	NC	---	YES
RADIUM-226	5.54E+00	1.50E+01	b	3.69E-01	no	no
THALLIUM-208	8.24E-01	NA	NA	---	---	YES

[1] Analytes identified as COPECs from Table D-1

[2] Exposure Point Concentration (EPC) = Reasonable Maximum Exposure (RME); The EPC is the lesser of the maximum detected concentration and the 95% upper confidence limit (UCL) on the mean concentration. RME from Appendix A, Table A-1 (0-1 ft)

[3] RSV from Attachment D-3 Table 1B

[4] b = LANL Low Effect ESL for Soil Media (2022)

[5] Refinement Level Hazard Quotient (HQ) = EPC / RSV

[6] COPC = Constituent of potential concern. Analytes identified as a COPC if the refinement level HQ>1

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Attachment D-1
EPA Region 4 Screening Tables for Soil

(March 2018)

Link: https://www.epa.gov/sites/default/files/2018-03/documents/era_regional_supplemental_guidance_report-march-2018_update.pdf

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Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Inorganic Compounds												
Metals												
Aluminum	7429-90-5	Narrative	a	All	Narrative	a	Narrative	a				
Antimony	7440-36-0	0.27	a	All	5	b	78	a	0.27	a		
Arsenic	7440-38-2	18	a	All	18	a	6.8	c	46	a	43	a
Barium	7440-39-9	330	a	All	110	c	330	a	2,000	a	820	c
Beryllium	7440-41-7	2.5	c	All	2.5	c	40	a	21	a		
Boron	7440-42-8	7.5	c	All	36	c			55	c	2	c
Cadmium	7440-43-9	0.36	a	All	32	a	140	a	0.36	a	0.77	a
Chromium – Total	7440-47-3	23	c	M,A					63	c	23	c
Chromium III	16065-83-1	26	a	M,A					34	a	26	a
Chromium VI	18540-29-9	0.34	c	All	0.35	c	0.34	c	130	a	140	c
Cobalt	7440-48-4	13	a	All	13	a			230	a	120	a
Copper	7440-50-8	28	a	All	70	a	80	a	49	a	28	a
Iron	7439-89-6	Narrative	a	All			Narrative	a				
Lead	7439-92-1	11	a	All	120	a	1,700	a	56	a	11	a
Lithium	7439-92-2	2	b	P,M	2	b			75	c		
Manganese	7439-96-5	220	a	All	220	a	450	a	4,000	a	4,300	a
Mercury (total)	7439-97-6	0.013	c	All	0.3	b	0.05	c	1.7	c	0.013	c
Methylmercury	22967-92-6	0.00035	c	All			2.5	c	0.0031	c	0.00035	c
Molybdenum	7439-98-7	2	b	All	2	b			4.8	f	15	c
Nickel	7440-02-0	38	a	All	38	a	280	a	130	a	210	a
Selenium	7782-49-2	0.52	a	All	0.52	a	4.1	a	0.63	a	1.2	a
Silver	7440-22-4	4.2	a	All	560	a			14	a	4.2	a
Strontium	7440-24-6	96	c	M					95	c		
Thallium	7440-28-0	0.05	c	All	0.05	c			0.42	c	4.5	c
Tin	7440-31-5	7.6	g	All	50	b			7.62	g		
Uranium	7440-61-1	25	c	All	25	c			480	c	1,100	c
Vanadium	7440-62-2	7.8	a	All	60	c			280	a	7.8	a
Zinc	7440-66-6	46	a	All	160	a	120	a	79	a	46	a
Other Inorganic												
Ammonia	7664-41-7											
Bromine (Total)	7726-95-6	10	b	P	10	b						
Cyanide (Total)	57-12-5	0.1	c	M,A					330	c	0.098	c

Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites (*continued)*

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Inorganic Compounds *(Continued)*												
Other Inorganics *(Continued)*												
Fluoride	16984-48-8	32	c	M,A					870	c	120	c
Fluorine	7782-41-4	200	b	P	200	b						
Iodine	7553-56-2	4	b	P	4	b						
Volatile Organic Compounds (VOCs)												
Chlorinated Alkanes												
1,1,1,2-Tetrachloroethane	630-20-6	0.07	d	SI			0.07	d	225	g		
1,1,2,2-Tetrachloroethane	79-34-5	0.127	g	All			0.19	d	0.127	g		
1,1,1-Trichloroethane	71-55-6	0.04	d	All			0.04	d	260	c		
1,1,2-Trichloroethane	79-00-5	0.32	d	All			0.32	d	28.6	g		
1,1-Dichloroethane	75-34-3	0.14	d	All			0.14	d	210	c		
1,2-Dichloroethane	107-06-2	0.4	d	All			0.40	d	27	c	0.85	c
1,2-Dichloropropane	78-87-5	0.28	d	All			0.28	d	32.7	g		
Dichloromethane (Methylene chloride)	75-09-2	0.21	d	All	1,600	c	0.21	d	2.6	c		
Trichloromethane (Chloroform)	67-66-3	0.05	d	All			0.05	d	8	c		
Tetrachloromethane (Carbon tetrachloride)	56-23-5	0.05	d	All			0.05	d	2.98	g		
Chlorinated Alkenes												
1,1-Dichloroethene/Dichloroethylene	75-35-4	0.04	d	All			0.04	d	11	c		
1,2-Dichloroethane (cis and trans)	540-59-0	0.04	d	All			0.04	d	24	c		
1,2-cis-Dichloroethylene	156-59-2	0.04	d	All			0.04	d				
1,2-trans-Dichloroethylene	156-60-5	0.04	d	All			0.04	d	0.784	g		
1,3-Dichloropropane	542-75-6	0.001	d	All			0.001	d				
Tetrachloroethylene (PCE)	127-18-4	0.06	d	All	10	c	0.06	d	0.18	c		
Trichloroethylene (TCE)	79-01-6	0.06	d	All			0.06	d	42	c		
Vinyl chloride	75-01-4	0.03	d	All			0.03	d	0.12	c		
Chlorobenzenes												
Chlorobenzene	108-90-7	2.4	c	All			2.4	c	43	c		
1,2-Dichlorobenzene	95-50-1	0.09	d	All			0.09	d	0.92	c		
1,3-Dichlorobenzene	541-73-1	0.08	d	All			0.08	d	0.74	c		
1,4-Dichlorobenzene	106-46-7	0.88	c	SI,M			1.2	c	0.89	c		
1,2,3-Trichlorobenzene	87-61-6	20	e	SI			20	e				
1,2,4-Trichlorobenzene	120-82-1	0.27	c	All			1.2	c	0.27	c		
1,3,5-Trichlorobenzene	108-70-3	0.07	d	All			0.07	d				

Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites (*continued)*

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Volatile Organic Compound (VOCs) *(Continued)*												
Monoaromatic Hydrocarbons												
1,2,4-Trimethylbenzene	95-63-6	0.09	d	All			0.09	d				
1,3,5-Trimethylbenzene	108-67-8	0.16	d	All			0.16	d				
Benzene	71-43-2	0.12	d	All			0.12	d	24	c		
Cymene, p- (4-Isopropyltoluene)	99-87-6	0.18	d	All			0.18	d				
Ethylbenzene	100-41-4	0.27	d	All			0.27	d	5.16	g		
Isopropylbenzene (Cumene)	98-82-8	0.04	d	All			0.04	d				
Styrene (Vinyl benzene)	100-42-5	1.2	c	All	3.2	c	1.2	c				
Toluene	108-88-3	0.15	d	All	200	c	0.15	d	23	c		
Xylenes (total)	1330-20-7	0.1	d	All	100	c	0.1	d	1.4	c	41	c
Ketones												
2-Butanone (Methyl Ethyl Ketone)	78-93-3	1.0	d	All			1.0	d	350	c		
2-Hexanone	591-78-6	0.36	c	SI,M,A			2.5	d	5.4	c	0.36	c
Acetone	67-64-1	1.2	c	M,A			0.04	d	1.2	c	7.5	c
Other VOCs												
Tribromomethane (Bromoform)	75-25-2	0.07	d	All			0.07	d	15.9	g		
Bromomethane (Methyl bromide)	74-83-9	0.002	d	All			0.002	d	0.24	g		
Carbon disulfide	75-15-0	0.005	d	All			0.005	d	0.81	c		
Ethylene glycol	107-21-1	0.31	d	All			0.31	d				
Hexachloroethane	67-72-1	0.024	d	All			0.024	d	0.6	g		
Hexane	110-54-3	0.007	d	All			0.007	d				
Chloroanilines												
3-Chloroaniline	108-42-9	20	b	P,SI	20	b	30	e				
4-Chloroaniline	106-47-8	1	c	P,SI	1	c	1.8	c	1.1	g		
3,4-Dichloroaniline	95-76-1	20	e	SI			20	e				
2,4,5-Trichloroaniline	636-30-6	20	e	P,SI	20	b	20	e				
Pentachloroaniline	527-20-8	100	e	SI			100	e				
Semivolatile Organic Compound (SVOCs)												
Chlorobenzenes												
1,2,3,4-Tetrachlorobenzene	634-66-2	10	e	SI			10	e				
1,2,4,5-Tetrachlorobenzene	95-94-3	0.18	d	All			0.18	d	2.02	g		
Hexachlorobenzene	118-74-1	0.079	c	All	10	c	10	c	0.2	c	0.079	c
Pentachlorobenzene	608-93-5	0.5	g	All			20	e	0.5	g		

Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites (*continued)*

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Semivolatile Organic Compound (SVOCs) (Continued)												
Dichlorophenols												
Dichlorophenols (2,3-), (2,4-), (2,5-), (2,6-)	120-83-2	0.05	d	All			0.05	d	87.5	g		
Dichlorophenols (3,4-), (3,5-)	95-77-2	20	e	P,SI	20	b	20	e				
Trichlorophenols												
2,4,5-Trichlorophenol	95-95-4	4	b	P,SI,M	4	b	9	e	14.1	g		
2,4,6-Trichlorophenol	88-06-2	9.94	g	SI,M			10	e	9.94	g		
Tetrachlorophenols												
2,3,4,5-Tetrachlorophenol	4901-51-3	20	e	SI			20	e				
Tetrachlorophenols (2,3,4,6-), (2,3,5,6-)	58-90-2	0.04	d	All			0.04	d	0.2	g		
Other Phenols												
Chlorophenols (2-), (4-)	95-57-8	0.06	d	All			0.06	d	0.54	c	0.39	c
3-Chlorophenol	108-43-0	7	e	P,SI	7	b	10	e				
2,4-Dimethylphenol	105-67-9	0.04	d	SI			0.04	d				
2,4-Dinitrophenol	51-28-5	0.061	g	All	20	b	0.15	d	0.061	g		
4-Nitrophenol	100-02-7	5.12	g	SI,M			7	e	5.12	g		
2-Methylphenol (o-Cresol)	95-48-7	0.1	d	All	0.67	c	0.1	d	580	c		
3-Methylphenol (m-Cresol)	108-39-4	0.09	d	All	0.69	c	0.09	d	3.49	g		
4-Methylphenol (p-Cresol)	106-44-5	0.08	d	All			0.08	d	163	g		
Nonylphenol	25154-52-3	1.27	d	SI			1.27	d				
Pentachlorophenol (PCP)	87-86-5	2.1	a	All	5	a	31	a	2.8	a	2.1	a
Phenol	108-95-2	0.79	c	All	0.79	c	1.8	c	37	c		
Energetic SVOCs												
2-Amino-4,6-dinitrotoluene	35572-78-2	14	c	SI,M,P	14	c	43	c	16	c		
4-Amino-2,6-dinitrotoluene	19406-51-0	12	c	SI,M,P	33	c	18	c	12	c		
1,3-Dinitrobenzene	99-65-0	0.034	d	All			0.034	d	0.072	c	0.079	c
2,4-Dinitrobenzene	121-14-2	6	c	SI,M,P	6	c	18	c	14	c		
2,6-Dinitrobenzene	606-20-2	4	c	All			30	c	4.0	c	52	c
HMX (Octahydro-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	16	c	SI,M,P	2,700	c	16	c	290	c		
Nitroglycerine	55-63-0	13	c	SI,M,P	21	c	13	c	70	c		
2-Nitrotoluene	88-72-2	0.19	d	All			0.19	d	9.8	c		
3-Nitrotoluene	99-08-1	0.13	d	All			0.13	d	12	c		
4-Nitrotoluene	99-99-0	0.14	d	All			0.14	d	21	c		
PETN (Pentaerythrite-tetranitrate)	78-11-5	2.2	d	SI,M			2.2	d	100	c		
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4	2.3	c	All	45.9	h	8.4	c	16	c	2.3	c

Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites (*continued*)

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Semivolatile Organic Compound (SVOCs) (Continued)												
Energetic SVOCs *(Continued)*												
Tetryl (Methyl-2,4,6-trinitrophenulnitroamine)	479-45-8	0.018	d	All	25	h	0.018	d	1.5	c		
1,3,5-Trinitrobenzene	99-35-4	0.3	h	All	0.3	h	10	c				
2,4,6-Trinitrotoluene (TNT)	118-96-7	7.5	c	All	62	c	32	c	95	c	7.5	c
Other SVOCs												
1,1'-Biphenyl	92-52-4	0.2	d	All	60	b	0.2	d				
3,3'-Dichlorobenzidine	91-94-1	0.03	d	All			0.03	d	0.646	g		
Benzoic acid	65-85-0	0.01	d	All			0.01	d	1	c		
Benzyl alcohol	100-51-6	0.002	d	All			0.002	d	120	c		
Carbazole	86-74-8	0.07	d	All			0.07	d	79	c		
Dibenzofuran	132-64-9	0.15	d	All	6.1	c	0.15	d				
Hexachlorobutadiene	87-68-3	0.009	d	All			0.009	d	0.04	g		
Hexachlorocyclopentadiene	77-47-4	0.001	d	All	10	b	0.001	d	0.755	g		
N-Nitrosodiphenylamine	86-30-6	0.545	g	All			20	e	0.545	g		
Nitrobenzene	98-95-3	2.2	c	SI,M			2.2	c	4.8	c		
Pentachloronitrobenzene	82-68-8	0.09	d	All			0.09	d	11	c	0.7	c
Phthalates												
Bis(2-ethylhexyl)phthalate	117-81-7	0.02	c	All			8.4	d	0.06	c	0.02	c
Butylbenzyl phthalate	85-68-7	0.59	d	All			0.59	d	90	c		
Diethylphthalate	84-66-2	0.25	d	All	100	c	0.25	d	3,600	c		
Dimethylphthalate	131-11-3	0.35	d	All			10	c	38	c		
Di-N-butyl phthalate	84-74-2	0.011	c	All	160	c	0.22	d	180	c	0.011	c
Di-N-octyl phthalate	117-84-0	0.91	c	All			303	d	0.91	c		
Polycyclic Aromatic Hydrocarbons (PAHs)												
Low Molecular Weight (PAHs)												
Acenaphthene	83-32-9	See Total			0.25	c	0.38	d	130	c		
Acenaphthylene	208-96-8	See Total					0.34	d	120	c		
Anthracene	120-12-7	See Total			6.8	c	0.0015	d	210	c		
Fluorene	86-73-7	See Total					3.7	c	250	c		
1-Methylnaphthalene	90-12-0	See Total					0.14	d				
2-Methylnaphthalene	91-57-6	See Total					0.11	d	16	c		
2,6-Dimethylnaphthalene	581-42-0	See Total					0.44	d				
2,3,5-Trimethylnaphthalene	2245-38-7	See Total					0.13	d				
Naphthalene	91-20-3	See Total			1.0	c	0.16	d	9.6	c		

Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites (*continued)*

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Semivolatile Organic Compound (SVOCs) (Continued)												
Polycyclic Aromatic Hydrocarbons (PAHs) ***(Continued)***												
Low Molecular Weight (PAHs) ***(Continued)***												
1-Methylphenanthrene	932-69-9	See Total					0.5	d			3.4	c
Phenanthrene	85-01-8	See Total					5.5	c	11	c		
Total Low Molecular Weight PAHs		*29*	*a*	*All*			*29*	*a*	*100*	*a*		
High Molecular Weight (PAHs)												
Benzo(a)anthracene	56-55-3	See Total			18	c	4.69	d	3.4	c	0.73	c
Benzo(b)fluoranthene	205-99-2	See Total			18	c	2.7	d	44	c		
Benzo(k)fluoranthene	207-08-9	See Total					0.13	d	71	c		
Benzo(g,h,i)perylene	191-24-2	See Total					0.07	d	25	c		
Benzo(a)pyrene	50-32-8	See Total					0.13	d	62	c		
Benzo(e)pyrene	192-97-2	See Total					0.25	d				
Chrysene	218-01-9	See Total					5.18	d	3.1	c		
Dibenzo(a,h)anthracene	53-70-3	See Total					0.06	d	14	c		
Fluoranthene	206-44-0	See Total					10	c	22	c		
Indeno(1,2,3-cd)pyrene	193-39-5	See Total					0.08	d	71	c		
Perylene	198-55-0	See Total					0.17	d				
Pyrene	129-00-0	See Total					10	c	23	c	33	c
Total High Molecular Weight PAHs		*1.1*	*a*	*M*			*18*	*a*	*1.1*	*a*		
Pesticides/Herbicides												
Acrolein	107-02-8	0.0003	d	All			0.0003	d	5.27	g		
Aldrin	309-00-2	0.03	c	SI,M			0.030	c	0.037	c		
Atrazine	1912-24-9	0.00005	d	SI			0.000	d				
alpha-benzene hexachloride (BHC)	319-84-6	0.0003	d	SI,M			0.00	d	59	c		
beta-benzene hexachloride (BHC)	319-85-7	0.0003	d	All			0.0003	d	0.27	c	14	
gamma-benzene hexachloride (BHC) (Lindane)	58-89-9	0.0031	d	All	0.1	c	0.0031	d	0.0095	c	0.21	
Carbaryl	63-25-2	0.0003	d	All			0.0003	d				
Carbofuran	1563-66-2	0.0008	d	All			0.0008	d				
alpha-Chlordane	5103-71-9	0.0029	d	All	2.2	c	0.0029	d	0.27	c	0.27	
gamma-Chlordane	12789-03-6	0.02	d	All	2.2	c	0.02	d	2.3	c	2.2	
Chloropyrifos	2921-88-2	0.003	d	All			0.003	d				
Dinoseb	88-85-7	0.015	d	All			0.015	d	0.022	g		
DDT/DDE/DDD (total)		0.021	a	All								
Diazinon	333-41-5	0.0037	d	All			0.0037	d				

Table D.1-1 Region 4 Soil Screening Values for Hazardous Waste Sites (*continued/end)*

Chemical	CAS	Screening-Level (mg/kg)	Ref.	Receptor	Plants	Ref.	Soil Invertebrates	Ref.	Mammalian	Ref.	Avian	Ref.
Pesticides/Herbicides *(continued)*												
Dieldrin	60-57-1	0.0029	d	All	10	c	0.0029	d	0.0049	a	0.022	a
alpha-Endosulfan	959-98-8	0.0009	d	All			0.0009	d	0.119	g		
Endosulfans (alpha and beta)	115-29-7	0.0009	d	All			0.0009	d	0.64	c	15	c
Endosulfan sulfate	1031-07-8	0.0065	d	All			0.0007	d	0.036	g		
Endrin	72-20-8	0.0019	c	All	0.0034	c	0.0019	d	0.023	c	0.0014	c
Guthion	86-50-0	0.00006	d	All			0.00006	d				
Heptachlor	76-44-8	0.0016	d	All	0.4	c	0.0016	d	0.059	c	0.3	c
Heptachlor epoxide	1024-57-3	0.00015	d	All			0.00015	d	0.152	g		
Hexachlorocyclopentadiene	77-47-4	0.0064	d	All	10	c	0.0064	d	0.755	g		
Kepone (Chlordecone)	143-50-0	0.017	d	All			0.017	d	0.022	c	1.3	c
Malathion	121-75-5	0.00004	d	All			0.00004	d				
Methoxychlor	72-43-5	0.0021	d	All			0.0021	d	5.1	c	18	c
Mirex	2385-85-5	0.0036	d	All			0.0036	d				
Parathion	56-38-2	0.00019	d	All			0.00019	d				
2,4,5-TP (Silvex)	93-72-1	0.055	d	All			0.055	d				
Simazine	122-34-9	0.0083	d	All			0.0083	d				
Toxaphene	8001-35-2	0.00015	d	All			0.00015	d	5.9	c	4.1	c
Trifluralin	1582-09-8	0.079	d	All			0.079	d				
Polychlorinated Biphenyls (PCBs) and Dioxins/Furans												
PCDDs, PCDFs (ΣTEQ)	1746-01-6	0.00000315	f	All			5	c	0.00000315	f	0.000016	f
PCBs (total)	1336-36-3	0.41	c	All	40	b	0.33	d	0.371	f	0.041	c
Other												
2-Nitroaniline	88-74-4	0.02	d	SI,M			0.02	d	5.3	c		
Diphenylamine	122-39-4	1.01	g	All			1.1	d	1.01	g	10	c
Trichlorofluoromethane	75-69-4	16.4	g	M					16.4	g		

Notes: All = All receptors; A – Avian, M – Mammals, P – Plants, SI – Soil Invertebrates, LMWPAHs have less than 4 rings, HMWPAHs have 4 or more rings
Table 3 Sources:
a – USEPA (2007): Ecological Soil Screening Levels.
b – Efroymson, R.A, M.E. Will, G.W. Suter, and A.C. Wooten, 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*, ES/ER/TM-95/R4, Oak Ridge National Laboratory, Oak Ridge, TN
c – Los Alamos National Laboratory (LANL), 2022. ECORISK Database Release 4.4, (µg/kg dw)
d – ECOSAR & Region 4 soil model.
e – Efroymson, R.A, M.E. Will, G.W. Suter, 1997b. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision, ES/ER/TM-126/R2, Oak Ridge National Laboratory, Oak Ridge, TN.
f – Efroymson, R.A, G.W. Suter, B.E. Sample, and D.S. Jones, 1997c. *Preliminary Remediation Goals for Ecological Endpoints*, ES/ER/TM-162/R2, Oak Ridge National Laboratory, Oak Ridge, TN.
g – EPA Region 5 RCRA Ecological Screening Levels (2003).

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Attachment D-2.

LANL No Effect and Low Effect ESLs
Ecorisk Database, Release 4.4,

Los Alamos National Laboratory, Los Alamos, NM (2017)

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Table D.2-1 Ecological Screening Levels

Analyte *(mg/kg, pCi/g)*	No Effect ESL		Low Effect ESL		Notes
	Sediment	Soil	Sediment	Soil	
1,2-Dichlorobenzene	1.00E+00	---	1.00E+01	9.20E+00	
1,3-Dichlorobenzene	8.20E-01	---	8.20E+00	7.40E+00	
1,4-Dichlorobenzene	3.00E-02	---	3.00E-01	3.50E+00	
2-Methylnaphthalene	---	1.60E+01	7.60E-01	1.60E+02	
Acetone	6.50E-02	1.20E+00	6.50E-01	6.30E+00	
Aldrin	4.20E-02	3.70E-02	2.10E-01	1.80E-01	
Alpha-chlordane	3.20E-03	2.70E-01	1.70E-02	1.30E+00	chlordane, wildlife based
Aluminum	2.50E+04	---	2.50E+05	---	
Anthracene	5.70E-02	2.10E+02	5.70E-01	9.00E+00	
Antimony	4.50E+01	2.30E+00	4.50E+02	2.30E+01	
Arsenic	9.70E+00	6.80E+00	3.30E+01	3.10E+01	
Barium	1.50E+02	7.20E+02	3.00E+02	2.60E+02	
Benzo(g,h,i)perylene	1.70E-01	2.50E+01	1.70E+00	2.50E+02	Sed, RSV, Total HMW-PAHs
Benzo[a]anthracene	1.00E-01	7.30E-01	1.00E+00	7.30E+00	Sed, RSV, Total HMW-PAHs
Benzo[a]pyrene	1.50E-01	6.20E+01	1.40E+00	1.90E+02	Sed, RSV, Total HMW-PAHs
Benzo[b]fluoranthene	1.90E-01	4.40E+01	1.90E+00	1.80E+02	Sed, RSV, Total HMW-PAHs
BERYLLIUM	6.60E+01	3.50E+01	6.60E+02	2.50E+01	
Bis(2-ethylhexyl)phthalate (DEHP)	2.60E-02	2.00E-02	2.60E-01	2.00E-01	
Cadmium	3.00E-01	2.70E-01	3.00E+00	3.00E+00	
Carbon Disulfide	1.30E+00	8.10E-01	1.30E+01	8.10E+00	
Cesium-137	7.20E+02	1.40E+03	7.20E+03	1.40E+04	
Chlorobenzene	3.00E-02	---	3.00E-01	2.40E+01	
Chromium	4.30E+01	2.30E+01	1.10E+02	7.30E+01	sediment, total chromium
Chrysene	1.60E-01	3.10E+00	1.20E+00	3.10E+01	Sed, RSV, Total HMW-PAHs
Cobalt	2.20E+02	7.60E+01	2.20E+03	1.30E+02	
Copper	2.30E+01	1.40E+01	6.90E+01	4.30E+01	
Cyanide	1.00E-01	9.80E-02	1.00E+00	9.80E-01	
DDD	8.20E-03	6.30E-03	4.20E-02	3.20E-02	sediment ESV/RSV 4,4'-DDD
DDE	3.10E-03	1.10E-01	3.10E-02	5.50E-01	sediment ESV/RSV 4,4'-DDE
DDT	4.10E-03	4.40E-02	4.10E-02	2.20E-01	sediment ESV/RSV 4'-DDT (aquatic life)
Dieldrin	1.90E-03	4.50E-03	1.90E-02	9.00E-03	sediment ESV/RSV Dieldrin *
Dimetyl phthalate	#N/A	#N/A	#N/A	#N/A	
Fluoranthene	4.20E-01	2.20E+01	2.20E+00	2.30E+01	sediment RSV Total HMW-PAHs
Fluorene	7.70E-02	---	5.30E-01	1.90E+01	sediment RSV Total HMW-PAHs
Gamma-chlordane	3.20E-03	2.20E+00	1.70E-02	1.10E+01	chlordane, wildlife based
Heptachlor	2.40E-03	---	1.60E-02	5.90E-01	
Hexavalent Chromium	6.60E+02	3.40E-01	6.60E+03	3.40E+00	sediment ESV/RSV chromium (total)
Indeno[1,2,3-cd]pyrene	2.00E-01	7.10E+01	2.00E+00	7.10E+02	sediment RSV Total HMW-PAHs
Iron	2.00E+04	---	4.00E+04	---	
Lead	2.60E+01	1.10E+01	5.20E+01	2.30E+01	Sediment ESV/RSV Methylmercury (wildlife based)
m,p-Xylene	1.30E-01	1.40E+00	1.30E+00	1.80E+00	sediment ESV/RSV Xylenes (total)
Magnesium	---	---	---	---	
Manganese	4.60E+02	1.10E+03	1.10E+03	1.10E+03	
Mercury	1.70E-02	1.30E-02	1.70E-01	1.30E-01	
Mercury methyl	4.50E-04	3.50E-04	4.50E-03	3.50E-03	
Methyl ethyl ketone	7.60E+00	---	2.27E+01	#N/A	
Nickel	1.20E+01	1.00E+01	2.40E+01	2.10E+01	
Phenanthrene	2.00E-01	1.10E+01	1.10E+00	---	sediment ESV/RSV Total LMW-PAHs

Table D.2-1 Ecological Screening Levels (*continued/end)*

Analyte *(mg/kg, pCi/g)*	No Effect ESL		Low Effect ESL		Notes
	Sediment	Soil	Sediment	Soil	
Potassium	---	---	---	---	
Pyrene	1.90E-01	2.00E+01	1.50E+00	2.00E+01	sediment ESV/RSV Total LMW-PAHs
Selenium	7.20E-01	7.00E-01	1.20E+00	1.00E+00	Selenium (wildlife)
Silver	5.00E-01	2.60E+00	5.00E+00	2.60E+01	
Sodium	---	---	---	---	
Thallium	7.30E-01	5.00E-01	7.30E+00	5.00E-01	
Thorium-228	6.40E+02	4.30E+02	6.40E+03	4.30E+02	
Thorium-230	5.80E+02	5.20E+02	5.80E+03	5.20E+02	
Thorium-232	6.90E+01	6.20E+01	6.90E+02	6.20E+01	
Toluene	1.00E-02	2.30E+01	1.00E-01	2.30E+02	
Uranium	1.00E+02	#N/A	1.00E+03	2.50E+02	
Uranium-233/234	---	4.40E+03	---	---	
Uranium-238	6.70E+02	2.00E+03	6.70E+03	2.00E+04	
Vanadium	2.90E+01	4.70E+00	5.90E+01	9.50E+00	
Zinc	6.30E+01	4.70E+01	6.30E+02	1.20E+02	

Attachment D-3

Derivation of ESVs and RSVs

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Table D.3-1 Soil Media, No Effect Screening Values

Derivation of Soil ESVs and RSVs
I. SOIL MEDIA
A. Screening Level (No Effect Screening Level)

Analyte *(mg/kg, pCi/g)*	EPA R4 Soil[1]	LANL Soil[2]	ESV	Notes
Acenaphthene	2.90E+01	2.00E+00	2.00E+00	4
Acenaphthylene	2.90E+01	1.20E+02	2.90E+01	4
Acetone	1.20E+00	1.20E+00	1.20E+00	
Actinium-228	---	---	---	
Aldrin	3.00E-02	3.70E-02	3.00E-02	
Alpha-benzene hexachloride (BHC)	3.00E-04	5.90E+01	3.00E-04	
Alpha-chlordane	2.90E-03	2.70E-01	2.90E-03	
Aluminum	---	---	---	
Anthracene	2.90E+01	2.10E+02	2.90E+01	4
Antimony	2.70E-01	2.30E+00	2.70E-01	
Aroclor 1242	4.10E-02	4.10E-02	4.10E-02	
Aroclor 1254	4.10E-02	4.10E-02	4.10E-02	
Aroclor 1260	4.10E-02	8.80E-01	4.10E-02	
Arsenic	1.80E+01	6.80E+00	6.80E+00	
Barium	3.30E+02	7.20E+02	3.30E+02	
Barium-133	---	---	---	
Benzene	1.20E-01	2.40E+01	1.20E-01	
Benzo(g,h,i)perylene	1.10E+00	2.50E+01	1.10E+00	5
Benzo[a]anthracene	1.10E+00	7.30E-01	7.30E-01	5
Benzo[a]pyrene	1.10E+00	6.20E+01	1.10E+00	5
Benzo[b]fluoranthene	1.10E+00	4.40E+01	1.10E+00	5
Benzo[k]fluoranthene	1.10E+00	7.10E+01	1.10E+00	5
Beryllium	2.50E+00	3.50E+01	2.50E+00	
Beta-benzene hexachloride (BHC)	3.00E-04	2.70E-01	3.00E-04	
Bis(2-ethylhexyl)phthalate (DEHP)	2.00E-02	2.00E-02	2.00E-02	
Bismuth-214	---	---	---	
Butylbenzyl phthalate	5.90E-01	9.00E+01	5.90E-01	
Cadmium	3.60E-01	2.70E-01	2.70E-01	
Calcium	---	---	---	
Caprolactam	---	---	---	
Carbazole	7.00E-02	7.90E+01	7.00E-02	
Carbon Disulfide	5.00E-03	8.10E-01	5.00E-03	
Cesium-137	---	1.40E+03	1.40E+03	6
Chloroform	5.00E-02	8.00E+00	5.00E-02	
Chloromethane (Methyl Chloride)	---	---	---	
Chromium	2.30E+01	2.30E+01	2.30E+01	
Hexavalent Chromium	3.40E-01	1.40E+02	3.40E-01	
Chrysene	1.10E+00	3.10E+00	1.10E+00	
Cobalt	1.30E+01	7.60E+01	1.30E+01	
Copper	2.80E+01	1.40E+01	1.40E+01	
Cumene (Isopropylbenzene)	4.00E-02	---	4.00E-02	
Cyanide	1.00E-01	9.80E-02	9.80E-02	
DDD	2.10E-02	6.30E-03	6.30E-03	
DDE	2.10E-02	1.10E-01	2.10E-02	
DDT	2.10E-02	4.40E-02	2.10E-02	
Dibenz[A,H]anthracene	1.10E+00	1.40E+01	1.10E+00	
Dichloromethane	2.10E-01	---	2.10E-01	
Dieldrin	2.90E-03	4.50E-03	2.90E-03	
Dimethyl phthalate	---	1.00E+02	1.00E+02	
Di-N-butylphthalate	1.10E-02	1.10E-02	1.10E-02	
Endosulfan sulfate	6.50E-03	---	6.50E-03	
Endrin ketone	---	---	---	

Table D.3-1 Soil Media, No Effect Screening Values (*continued/end*)

Derivation of Soil ESVs and RSVs
I. SOIL MEDIA
A. Screening Level (No Effect Screening Level)

Analyte *(mg/kg, pCi/g)*	EPA R4 Soil[1]	LANL Soil[2]	ESV	Notes
Fluoranthene	1.10E+00	2.20E+01	1.10E+00	
Gamma-chlordane	2.00E-02	2.20E+00	2.00E-02	
Gamma-BHC	2.40E+00	4.90E-03	4.90E-03	
Heptachlor epoxide	1.50E-04	---	1.50E-04	
Indeno[1,2,3-cd]pyrene	1.10E+00	7.10E+01	1.10E+00	5
Iron	---	---	---	
Lead	1.10E+01	1.10E+01	1.10E+01	
Lead-212	---	---	---	
Lead-214	---	---	---	
Lindane (Gamma BHC)	---	9.50E-03	9.50E-03	
m,p-Xylene	1.00E-01	1.40E+00	1.00E-01	7
Magnesium	---	---	---	
Manganese	2.20E+02	1.10E+03	2.20E+02	
Mercury	1.30E-02	1.30E-02	1.30E-02	
Methylmercury	3.50E-04	3.50E-04	3.50E-04	
Methyl acetate	---	---	---	
Methyl ethyl ketone	1.00E+00	---	1.00E+00	
2-Methylnaphthalene	2.90E+01	1.60E+01	1.60E+01	
Naphthalene	2.90E+01	3.40E+00	3.40E+00	
Nickel	3.80E+01	1.00E+01	1.00E+01	
Pentachlorophenol	2.10E+00	3.60E+00	2.10E+00	
Phenanthrene	2.90E+01	1.10E+01	1.10E+01	
Potassium	---	---	---	
Potassium-40	---	---	---	
Pyrene	1.10E+00	2.00E+01	1.10E+00	
Radium-226	---	8.20E+00	8.20E+00	
Radium-228	---	1.10E+01	1.10E+01	
Selenium	5.20E-01	7.00E-01	5.20E-01	
Silver	4.20E+00	2.60E+00	2.60E+00	
Sodium	---	---	---	
Styrene	1.20E+00	1.20E+01	1.20E+00	
Tetrachloroethylene (PCE)	6.00E-02	1.80E-01	6.00E-02	
Thallium	5.00E-02	5.00E-02	5.00E-02	
Thallium-208	---	---	---	
Thorium-228	---	4.30E+02	4.30E+02	
Thorium-230	---	5.20E+02	5.20E+02	
Thorium-232	---	6.20E+01	6.20E+01	
Toluene	1.50E-01	2.30E+01	1.50E-01	
Tritium	---	2.40E+05	2.40E+05	
Uranium-233/234	---	4.40E+03	4.40E+03	8
Uranium-235	---	4.40E+03	4.40E+03	
Uranium-238	---	2.00E+03	2.00E+03	
Vanadium	7.80E+00	4.70E+00	4.70E+00	
Zinc	4.60E+01	4.70E+01	4.60E+01	

1 - Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance March 2018 Update (2018) (Attachment D-1)
2 - Los Alamos National Laboratory No Effect ESL for Soil Media (Attachment D-2) 2021 update, electronic file2017
3 - Ecological Screening Value= lowest (most conservative) screening value highlighted in yellow
4 - Values for EPA Region 4 soil are for total Low Molecular Weight PAHs
5 - Values for EPA Region 4 soil are for total High Molecular Weight PAHs
6 – Screening value is for Cesium-137 + Barium-137
7 – Values are for "Xylenes"
8 – Screening value is for Uranium-234.

Table D.3-2 Soil Media, Refinement Values

Derivation of ESVs and RSVs
I. SOIL MEDIA
B. Refinement Level (Low Effect Screening Level)

Analyte *(mg/kg, pCi/g)*	EPA R4 Soil[1]	LANL Soil[2]	RSV[3]	Notes
Acenaphthene	NA	2.00E+00	2.00E+00	
Acenaphthylene	NA	1.20E+03	1.20E+03	
Acetone	NA	6.30E+00	6.30E+00	
Aldrin	NA	1.80E-01	1.80E-01	
Aluminum	NA	---	---	
Americium-241	NA	4.30E+05	4.30E+05	
Amino-2,6-dinitrotoluene[4-]	NA	1.20E+02	1.20E+02	
Amino-4,6-dinitrotoluene[2-]	NA	1.40E+02	1.40E+02	
Anthracene	NA	9.00E+00	9.00E+00	
Antimony	NA	2.30E+01	2.30E+01	
Aroclor 1016	NA	3.10E+00	3.10E+00	
Aroclor 1242	NA	4.10E-01	4.10E-01	
Aroclor 1248	NA	7.30E-02	7.30E-02	
Aroclor 1254	NA	4.10E-01	4.10E-01	
Aroclor 1260	NA	8.80E+00	8.80E+00	
Arsenic	NA	3.10E+01	3.10E+01	
Barium	NA	2.60E+02	2.60E+02	
Benzene	NA	2.40E+02	2.40E+02	
Benzo[a]anthracene	NA	7.30E+00	7.30E+00	
Benzo[a]pyrene	NA	1.90E+02	1.90E+02	
Benzo[b]fluoranthene	NA	1.80E+02	1.80E+02	
Benzo(g,h,i)perylene	NA	2.50E+02	2.50E+02	
Benzo[k]fluoranthene	NA	7.10E+02	7.10E+02	
Benzoic Acid	NA	1.00E+01	1.00E+01	
Benzyl Alcohol	NA	1.20E+03	1.20E+03	
Beryllium	NA	2.50E+01	2.50E+01	
BHC[alpha-]	NA	5.90E+02	5.90E+02	
BHC[beta-]	NA	1.30E+00	1.30E+00	
BHC[gamma-]	NA	9.50E-02	9.50E-02	
Bis(2-ethylhexyl)phthalate (DEHP)	NA	2.00E-01	2.00E-01	
Boron	NA	1.00E+01	1.00E+01	
Butanone[2-]	NA	9.20E+02	9.20E+02	
Butyl Benzyl Phthalate	NA	9.00E+02	9.00E+02	
Cadmium	NA	3.00E+00	3.00E+00	
Carbazole	NA	7.90E+02	7.90E+02	
Carbon Disulfide	NA	8.10E+00	8.10E+00	
Cesium-134	NA	6.80E+03	6.80E+03	
Cesium-137	NA	1.40E+04	1.40E+04	4
Alpha-chlordane	NA	1.30E+00	1.30E+00	
Gamma-chlordane	NA	1.10E+01	1.10E+01	
Chloroaniline[4-]	NA	1.00E+01	1.00E+01	
Chlorobenzene	NA	2.40E+01	2.40E+01	
Chloroform	NA	2.10E+01	2.10E+01	
Chlorophenol[2-]	NA	3.90E+00	3.90E+00	
Chromium	NA	7.30E+01	7.30E+01	5
Chromium(+6)	NA	3.40E+00	3.40E+00	
Chrysene	NA	3.10E+01	3.10E+01	
Cobalt	NA	1.30E+02	1.30E+02	
Cobalt-60	NA	7.60E+03	7.60E+03	
Copper	NA	4.30E+01	4.30E+01	
Cyanide	NA	9.80E-01	9.80E-01	6

Table D.3-2 Soil Media, Refinement Values *(continued)*

Derivation of ESVs and RSVs
I. SOIL MEDIA
B. Refinement Level (Low Effect Screening Level)

Analyte *(mg/kg, pCi/g)*	EPA R4 Soil[1]	LANL Soil[2]	RSV[3]	Notes
DDD	NA	3.20E-02	3.20E-02	7
DDE	NA	5.50E-01	5.50E-01	8
DDT	NA	2.20E-01	2.20E-01	9
Dibenzo(a,h)anthracene	NA	1.40E+02	1.40E+02	
Dibenzofuran	NA	6.10E+01	6.10E+01	
1,2-Dichlorobenzene	NA	9.20E+00	9.20E+00	
1,3-Dichlorobenzene	NA	7.40E+00	7.40E+00	
1,4-Dichlorobenzene	NA	3.50E+00	3.50E+00	
Dichloroethane[1,1-]	NA	2.10E+03	2.10E+03	
Dichloroethane[1,2-]	NA	1.60E+00	1.60E+00	
Dichloroethene[1,1-]	NA	1.10E+02	1.10E+02	
Dichloroethene[cis/trans-1,2-]	NA	2.40E+02	2.40E+02	
Dieldrin	NA	9.00E-03	9.00E-03	
Diethyl Phthalate	NA	1.00E+03	1.00E+03	
Dimethyl Phthalate	NA	1.00E+02	1.00E+02	
Di-n-Butyl Phthalate	NA	1.10E-01	1.10E-01	
Dinitrobenzene[1,3-]	NA	1.60E-01	1.60E-01	
Dinitrotoluene[2,4-]	NA	6.00E+01	6.00E+01	
Dinitrotoluene[2,6-]	NA	4.00E+01	4.00E+01	
Di-n-octylphthalate	NA	9.10E+00	9.10E+00	
Diphenylamine	NA	1.30E+01	1.30E+01	
Endosulfan	NA	6.40E+00	6.40E+00	
Endrin	NA	1.40E-02	1.40E-02	
Europium-152	NA	5.20E+03	5.20E+03	
Fluoranthene	NA	2.30E+01	2.30E+01	
Fluorene	NA	1.90E+01	1.90E+01	
Fluoride	NA	1.20E+03	1.20E+03	
Heptachlor	NA	5.90E-01	5.90E-01	
Hexachlorobenzene	NA	7.90E-01	7.90E-01	
Hexanone[2-]	NA	3.60E+00	3.60E+00	
HMX	NA	1.60E+02	1.60E+02	
Indeno[1,2,3-cd]pyrene	NA	7.10E+02	7.10E+02	
Iodomethane	NA	7.60E-02	7.60E-02	
Iron	NA	---	---	
Kepone	NA	1.10E-01	1.10E-01	
Lead	NA	2.30E+01	2.30E+01	
Lead-210	NA	1.20E+04	1.20E+04	
Lithium	NA	3.50E+02	3.50E+02	
Manganese	NA	1.10E+03	1.10E+03	
Mercury (inorganic)	NA	1.30E-01	1.30E-01	
Mercury methyl	NA	3.50E-03	3.50E-03	
Methoxychlor[4,4'-]	NA	1.00E+01	1.00E+01	
Methyl-2-pentanone[4-]	NA	9.70E+01	9.70E+01	
Methylene Chloride	NA	2.20E+01	2.20E+01	
2-Methylnaphthalene	NA	1.60E+02	1.60E+02	
Methylphenol[2-]	NA	7.00E+00	7.00E+00	
Methylphenol[3-]	NA	7.00E+00	7.00E+00	
Molybdenum	NA	1.50E+02	1.50E+02	
Naphthalene	NA	1.00E+01	1.00E+01	
Neptunium-237	NA	5.00E+02	5.00E+02	
Nickel	NA	2.10E+01	2.10E+01	
Nitroaniline[2-]	NA	1.00E+01	1.00E+01	

Table D.3-2 Soil Media, Refinement Values *(continued)*

Derivation of ESVs and RSVs
I. SOIL MEDIA
B. Refinement Level (Low Effect Screening Level)

Analyte *(mg/kg, pCi/g)*	EPA R4 Soil[1]	LANL Soil[2]	RSV[3]	Notes
Nitrobenzene	NA	2.20E+01	2.20E+01	
Nitroglycerine	NA	1.30E+02	1.30E+02	
Nitrotoluene[2-]	NA	9.80E+01	9.80E+01	
Nitrotoluene[3-]	NA	1.20E+02	1.20E+02	
Nitrotoluene[4-]	NA	2.10E+02	2.10E+02	
Pentachloronitrobenzene	NA	7.00E+00	7.00E+00	
Pentachlorophenol	NA	3.60E+00	3.60E+00	
PETN	NA	1.00E+03	1.00E+03	
Phenanthrene	NA	---	---	
Phenol	NA	8.00E+00	8.00E+00	
Plutonium-238	NA	8.20E+03	8.20E+03	
Plutonium-239, 240	NA	8.70E+03	8.70E+03	
Plutonium-241	NA	1.70E+05	1.70E+05	
Pyrene	NA	2.00E+01	2.00E+01	
Radium-226	NA	1.50E+01	1.50E+01	
Radium-228	NA	1.20E+01	1.20E+01	
RDX	NA	4.40E+00	4.40E+00	
Selenium	NA	1.00E+00	1.00E+00	
Silver	NA	2.60E+01	2.60E+01	
Sodium-22	NA	4.60E+04	4.60E+04	
Strontium (stable)	NA	9.50E+02	9.50E+02	
Strontium-90 + Yittrium-90	NA	3.40E+03	3.40E+03	
Styrene	NA	1.20E+01	1.20E+01	
Tetrachlorodibenzodioxin[2,3,7,8-]	NA	1.20E+02	1.20E+02	
Tetrachloroethene	NA	9.40E-01	9.40E-01	
Tetryl	NA	7.20E+00	7.20E+00	
Thallium	NA	5.00E-01	5.00E-01	
Thorium-228	NA	4.30E+02	4.30E+02	
Thorium-229	NA	4.70E+02	4.70E+02	
Thorium-230	NA	5.20E+02	5.20E+02	
Thorium-232	NA	6.20E+01	6.20E+01	
Titanium	NA	7.70E+02	7.70E+02	
Toluene	NA	2.30E+02	2.30E+02	
Toxaphene (Technical Grade)	NA	4.10E+01	4.10E+01	
Trichlorobenzene[1,2,4-]	NA	2.70E+00	2.70E+00	
Trichloroethane[1,1,1-]	NA	2.60E+03	2.60E+03	
Trichloroethene	NA	4.20E+02	4.20E+02	
Trichlorofluoromethane	NA	3.50E+02	3.50E+02	
Trinitrobenzene[1,3,5-]	NA	2.80E+01	2.80E+01	
Trinitrotoluene[2,4,6-]	NA	1.30E+01	1.30E+01	
Tritium	NA	3.60E+05	3.60E+05	
Uranium	NA	2.50E+02	2.50E+02	
Uranium-233	NA	4.40E+03	4.40E+03	
Uranium-234	NA	4.40E+03	4.40E+03	
Uranium-235	NA	4.40E+03	4.40E+03	
Uranium-236	NA	4.70E+04	4.70E+04	
Uranium-238	NA	2.00E+04	2.00E+04	
Vanadium	NA	9.50E+00	9.50E+00	
Vinyl Chloride	NA	1.20E+00	1.20E+00	
m,p-Xylene	NA	1.80E+00	1.80E+00	10
Zinc	NA	1.20E+02	1.20E+02	

Table D.3-2 Soil Media, Refinement Values *(continued/end)*

1 - Table 3 in EPA Region 4 Ecological Risk Assessment Supplemental Guidance March 2018 Update (2018) (Attachment D-1)
2 - Los Alamos National Laboratory Low Effect ESL for Soil Media (2017) (Attachment D-2)
3 - Refinement Screening Value= lowest (most conservative) screening value
4 – Screening value is for Cesium-137 + Barium-137
5 - Values for Chromium (Total)
6 – Value for Cyanide (total)
7 - Value for DDD[4,4'-]
8 - Value for DDE[4,4'-]
9 - Value for DDT[4,4'-]
10 – Value for Xylenes

Attachment D-4

Uncertainty Tables

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Table D.4-1. Uncertainty Evaluation for Remaining Coal Ash and Coal Fines OU (Soil 0 to 0.3 m [0 to 1 ft])

Analyte[1]	Exposure Point Concentration[2]	American Kestrel (Avian top carnivore)		American Kestrel (insectivore / carnivore)		American Robin (Avian herbivore)		American Robin (Avian insectivore)	
		RSV	HQ	RSV	HQ	RSV	HQ	RSV	HQ
ARSENIC	3.76E+01	7.40E+03	5.08E-03	1.00E+03	3.76E-02	3.40E+02	1.11E-01	1.50E+02	2.51E-01
SELENIUM	2.59E+00	1.40E+02	1.85E-02	7.50E+00	3.46E-01	1.90E+00	1.36E+00	1.40E+00	1.85E+00
VANADIUM	3.30E+01	2.30E+02	1.43E-01	1.10E+02	3.00E-01	1.30E+01	2.53E+00	9.50E+00	3.47E+00

Analyte[1]	American Robin (Avian omnivore)		Deer mouse (Mammalian omnivore)		Earthworm (Soil-dwelling invertebrate)		Gray Fox (Mammalian top carnivore)	
	RSV	HQ	RSV	HQ	RSV	HQ	RSV	HQ
ARSENIC	2.10E+02	1.79E-01	5.10E+01	7.37E-01	6.80E+01	5.53E-01	1.30E+03	2.89E-02
SELENIUM	1.60E+00	1.62E+00	1.20E+00	2.16E+00	4.10E+01	6.32E-02	1.30E+02	1.99E-02
VANADIUM	1.10E+01	3.00E+00	1.00E+03	3.30E-02	NA	NC	6.90E+03	4.78E-03

Analyte[1]	Montane Shrew (Mammalian Insectivore)		Mountain cottontail (Mammalian herbivore)	
	RSV	HQ	RSV	HQ
ARSENIC	3.10E+01	1.21E+00	1.80E+02	2.09E-01
SELENIUM	1.00E+00	2.59E+00	3.40E+00	7.62E-01
VANADIUM	6.10E+02	5.40E-02	1.50E+03	2.20E-02

1 – Analytes identified as COPCs from Table D-2
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. RME from Appendix A Table A.1 (0-1 ft)
RSV = Receptor-specific low effect ecological screening level from Attachment D-6.
Hazard Quotient (HQ) = EPC/RSV

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Attachment D-5

RESRAD Biota Values

Argonne National Laboratory (2006) RESRAD BIOTA (v.1.8) [software]

(www.ead.anl.gov/resrad website accessed January 20, 2017

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Table D.5-1 Sediment/Soil Tier 3 Biota Concentration Guides

Radionuclide	Tier 3 Terrestrial Animal Soil	Tier 3 Aquatic Animal Sediment	Tier 3 Riparian Animal Sediment	Minimum of Tier 3
	BCG *(pCi/g)*			
Actinium-228	---	---	---	---
Americium-243	---	---	---	---
Barium-133	---	---	---	---
Bismuth-212	---	---	---	---
Bismuth-214	---	---	---	---
Californium-244	---	---	---	---
Carbon-14	4,760	789,000	59,000	4,760
Cobalt-58	1,790	38,600	3,790	1,790
Curium-244	4,060	4,000,000	5,200	4,060
Curium-245 and Curium-246	---	---	---	---
Europium-155	15,800	318,000	31,600	15,800
Lead-212	---	---	---	---
Lead-214	---	---	---	---
Manganese-54	---	---	---	---
Neptunium-239	---	---	---	---
Potassium-40	119	57,900	4,420	119
Promethium-146	---	---	---	---
Radium-224	---	---	---	---
Ruthenium-106	---	---	---	---
Thallium-208	---	---	---	---
Thorium-231	---	---	---	---
Thorium-234	2,160	43,200	4,320	2,160
Tin-113	---	---	---	---
Zinc-65	413	65,800	1,430	413
Zirconium-95	1,170	23,500	2,330	1,170

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Attachment D-6

Los Alamos National Laboratory Receptor-Specific ESLs (2017)

Available at the following link (see pages 481-520):
https://rais.ornl.gov/documents/ECO_BENCH_LANL.pdf

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Table D.6-1 LANL Receptor-Specific Ecological Screening Levels

Analyte Group	Analyte Name	Analyte Code	ESL Medium	ESL Receptor	No Effect ESL	Low Effect ESL	Units	Minimum ESL
INORG	Aluminum	AL	SOIL	American kestrel (Avian top carnivore)				
INORG	Aluminum	AL	SOIL	American kestrel (insectivore / carnivore)				
INORG	Aluminum	AL	SOIL	American robin (Avian herbivore)				
INORG	Aluminum	AL	SOIL	American robin (Avian insectivore)				
INORG	Aluminum	AL	SOIL	American robin (Avian omnivore)				
INORG	Aluminum	AL	SOIL	Deer mouse (Mammalian omnivore)				
INORG	Aluminum	AL	SOIL	Earthworm (Soil-dwelling invertebrate)				
INORG	Aluminum	AL	SOIL	Generic plant (Terrestrial autotroph - producer)				
INORG	Aluminum	AL	SOIL	Gray fox (Mammalian top carnivore)				
INORG	Aluminum	AL	SOIL	Montane shrew (Mammalian insectivore)				
INORG	Aluminum	AL	SOIL	Mountain cottontail (Mammalian herbivore)				
INORG	Arsenic	AS	SOIL	American kestrel (Avian top carnivore)	740	7400	mg/kg	
INORG	Arsenic	AS	SOIL	American kestrel (insectivore / carnivore)	100	1000	mg/kg	
INORG	Arsenic	AS	SOIL	American robin (Avian herbivore)	34	340	mg/kg	
INORG	Arsenic	AS	SOIL	American robin (Avian insectivore)	15	150	mg/kg	
INORG	Arsenic	AS	SOIL	American robin (Avian omnivore)	21	210	mg/kg	
INORG	Arsenic	AS	SOIL	Deer mouse (Mammalian omnivore)	32	51	mg/kg	
INORG	Arsenic	AS	SOIL	Earthworm (Soil-dwelling invertebrate)	6.8	68	mg/kg	MINIMUM
INORG	Arsenic	AS	SOIL	Generic plant (Terrestrial autotroph - producer)	18	91	mg/kg	
INORG	Arsenic	AS	SOIL	Gray fox (Mammalian top carnivore)	820	1300	mg/kg	
INORG	Arsenic	AS	SOIL	Montane shrew (Mammalian insectivore)	19	31	mg/kg	
INORG	Arsenic	AS	SOIL	Mountain cottontail (Mammalian herbivore)	110	180	mg/kg	
INORG	Barium	BA	SOIL	American kestrel (Avian top carnivore)	24000	44000	mg/kg	
INORG	Barium	BA	SOIL	American kestrel (insectivore / carnivore)	7500	13000	mg/kg	
INORG	Barium	BA	SOIL	American robin (Avian herbivore)	720	1200	mg/kg	
INORG	Barium	BA	SOIL	American robin (Avian insectivore)	820	1400	mg/kg	
INORG	Barium	BA	SOIL	American robin (Avian omnivore)	770	1300	mg/kg	
INORG	Barium	BA	SOIL	Deer mouse (Mammalian omnivore)	1800	8700	mg/kg	
INORG	Barium	BA	SOIL	Earthworm (Soil-dwelling invertebrate)	330	3200	mg/kg	

Table D-6 LANL Receptor-Specific Ecological Screening Levels *(continued)*

Analyte Group	Analyte Name	Analyte Code	ESL Medium	ESL Receptor	No Effect ESL	Low Effect ESL	Units	Minimum ESL
INORG	Barium	BA	SOIL	Generic plant (Terrestrial autotroph - producer)	110	260	mg/kg	MINIMUM
INORG	Barium	BA	SOIL	Gray fox (Mammalian top carnivore)	41000	190000	mg/kg	
INORG	Barium	BA	SOIL	Montane shrew (Mammalian insectivore)	2100	10000	mg/kg	
INORG	Barium	BA	SOIL	Mountain cottontail (Mammalian herbivore)	2900	14000	mg/kg	
INORG	Beryllium	BE	SOIL	Deer mouse (Mammalian omnivore)	56	560	mg/kg	
INORG	Beryllium	BE	SOIL	Earthworm (Soil-dwelling invertebrate)	40	400	mg/kg	
INORG	Beryllium	BE	SOIL	Generic plant (Terrestrial autotroph - producer)	2.5	25	mg/kg	MINIMUM
INORG	Beryllium	BE	SOIL	Gray fox (Mammalian top carnivore)	420	4200	mg/kg	
INORG	Beryllium	BE	SOIL	Montane shrew (Mammalian insectivore)	35	350	mg/kg	
INORG	Beryllium	BE	SOIL	Mountain cottontail (Mammalian herbivore)	89	890	mg/kg	
INORG	Copper	CU	SOIL	American kestrel (Avian top carnivore)	1100	3500	mg/kg	
INORG	Copper	CU	SOIL	American kestrel (insectivore / carnivore)	80	240	mg/kg	
INORG	Copper	CU	SOIL	American robin (Avian herbivore)	34	100	mg/kg	
INORG	Copper	CU	SOIL	American robin (Avian insectivore)	14	43	mg/kg	MINIMUM
INORG	Copper	CU	SOIL	American robin (Avian omnivore)	20	60	mg/kg	
INORG	Copper	CU	SOIL	Deer mouse (Mammalian omnivore)	63	100	mg/kg	
INORG	Copper	CU	SOIL	Earthworm (Soil-dwelling invertebrate)	80	530	mg/kg	
INORG	Copper	CU	SOIL	Generic plant (Terrestrial autotroph - producer)	70	490	mg/kg	
INORG	Copper	CU	SOIL	Gray fox (Mammalian top carnivore)	4000	6700	mg/kg	
INORG	Copper	CU	SOIL	Montane shrew (Mammalian insectivore)	42	70	mg/kg	
INORG	Copper	CU	SOIL	Mountain cottontail (Mammalian herbivore)	260	430	mg/kg	
INORG	Lead	PB	SOIL	American kestrel (Avian top carnivore)	540	1000	mg/kg	
INORG	Lead	PB	SOIL	American kestrel (insectivore / carnivore)	83	160	mg/kg	
INORG	Lead	PB	SOIL	American robin (Avian herbivore)	18	36	mg/kg	
INORG	Lead	PB	SOIL	American robin (Avian insectivore)	11	23	mg/kg	MINIMUM
INORG	Lead	PB	SOIL	American robin (Avian omnivore)	14	28	mg/kg	
INORG	Lead	PB	SOIL	Deer mouse (Mammalian omnivore)	120	230	mg/kg	
INORG	Lead	PB	SOIL	Earthworm (Soil-dwelling invertebrate)	1700	8400	mg/kg	
INORG	Lead	PB	SOIL	Generic plant (Terrestrial autotroph - producer)	120	570	mg/kg	
INORG	Lead	PB	SOIL	Gray fox (Mammalian top carnivore)	3700	7000	mg/kg	

Table D-6 LANL Receptor-Specific Ecological Screening Levels *(continued)*

Analyte Group	Analyte Name	Analyte Code	ESL Medium	ESL Receptor	No Effect ESL	Low Effect ESL	Units	Minimum ESL
INORG	Lead	PB	SOIL	Montane shrew (Mammalian insectivore)	93	170	mg/kg	
INORG	Lead	PB	SOIL	Mountain cottontail (Mammalian herbivore)	310	600	mg/kg	
INORG	Manganese	MN	SOIL	American kestrel (Avian top carnivore)	60000	120000	mg/kg	
INORG	Manganese	MN	SOIL	American kestrel (insectivore / carnivore)	24000	50000	mg/kg	
INORG	Manganese	MN	SOIL	American robin (Avian herbivore)	1300	2700	mg/kg	
INORG	Manganese	MN	SOIL	American robin (Avian insectivore)	2200	4700	mg/kg	
INORG	Manganese	MN	SOIL	American robin (Avian omnivore)	1600	3500	mg/kg	
INORG	Manganese	MN	SOIL	Deer mouse (Mammalian omnivore)	1400	5400	mg/kg	
INORG	Manganese	MN	SOIL	Earthworm (Soil-dwelling invertebrate)	450	4500	mg/kg	
INORG	Manganese	MN	SOIL	Generic plant (Terrestrial autotroph - producer)	220	1100	mg/kg	MINIMUM
INORG	Manganese	MN	SOIL	Gray fox (Mammalian top carnivore)	40000	150000	mg/kg	
INORG	Manganese	MN	SOIL	Montane shrew (Mammalian insectivore)	2800	10000	mg/kg	
INORG	Manganese	MN	SOIL	Mountain cottontail (Mammalian herbivore)	2000	7500	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	American kestrel (Avian top carnivore)	0.32	3.2	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	American kestrel (insectivore / carnivore)	0.058	0.58	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	American robin (Avian herbivore)	0.067	0.67	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	American robin (Avian insectivore)	0.013	0.13	mg/kg	MINIMUM
INORG	Mercury (inorganic)	HGI	SOIL	American robin (Avian omnivore)	0.022	0.22	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	Deer mouse (Mammalian omnivore)	3	30	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	Earthworm (Soil-dwelling invertebrate)	0.05	0.5	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	Generic plant (Terrestrial autotroph - producer)	34	64	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	Gray fox (Mammalian top carnivore)	76	760	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	Montane shrew (Mammalian insectivore)	1.7	17	mg/kg	
INORG	Mercury (inorganic)	HGI	SOIL	Mountain cottontail (Mammalian herbivore)	23	230	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	American kestrel (Avian top carnivore)	0.009	0.09	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	American kestrel (insectivore / carnivore)	0.0015	0.015	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	American robin (Avian herbivore)	0.066	0.66	mg/kg	

Table D-6 LANL Receptor-Specific Ecological Screening Levels *(continued)*

Analyte Group	Analyte Name	Analyte Code	ESL Medium	ESL Receptor	No Effect ESL	Low Effect ESL	Units	Minimum ESL
INORG	Mercury (methyl)	HGM	SOIL	American robin (Avian insectivore)	0.00035	0.0035	mg/kg	MINIMUM
INORG	Mercury (methyl)	HGM	SOIL	American robin (Avian omnivore)	0.00071	0.0071	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	Deer mouse (Mammalian omnivore)	0.0062	0.031	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	Earthworm (Soil-dwelling invertebrate)	2.5	12	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	Gray fox (Mammalian top carnivore)	0.14	0.74	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	Montane shrew (Mammalian insectivore)	0.0031	0.015	mg/kg	
INORG	Mercury (methyl)	HGM	SOIL	Mountain cottontail (Mammalian herbivore)	1.9	9.8	mg/kg	
INORG	Nickel	NI	SOIL	American kestrel (Avian top carnivore)	2000	8100	mg/kg	
INORG	Nickel	NI	SOIL	American kestrel (insectivore / carnivore)	110	440	mg/kg	
INORG	Nickel	NI	SOIL	American robin (Avian herbivore)	120	500	mg/kg	
INORG	Nickel	NI	SOIL	American robin (Avian insectivore)	20	81	mg/kg	
INORG	Nickel	NI	SOIL	American robin (Avian omnivore)	35	130	mg/kg	
INORG	Nickel	NI	SOIL	Deer mouse (Mammalian omnivore)	20	40	mg/kg	
INORG	Nickel	NI	SOIL	Earthworm (Soil-dwelling invertebrate)	280	1300	mg/kg	
INORG	Nickel	NI	SOIL	Generic plant (Terrestrial autotroph - producer)	38	270	mg/kg	
INORG	Nickel	NI	SOIL	Gray fox (Mammalian top carnivore)	1200	2500	mg/kg	
INORG	Nickel	NI	SOIL	Montane shrew (Mammalian insectivore)	10	21	mg/kg	MINIMUM
INORG	Nickel	NI	SOIL	Mountain cottontail (Mammalian herbivore)	270	540	mg/kg	
INORG	Selenium	SE	SOIL	American kestrel (Avian top carnivore)	74	140	mg/kg	
INORG	Selenium	SE	SOIL	American kestrel (insectivore / carnivore)	3.7	7.5	mg/kg	
INORG	Selenium	SE	SOIL	American robin (Avian herbivore)	0.98	1.9	mg/kg	
INORG	Selenium	SE	SOIL	American robin (Avian insectivore)	0.71	1.4	mg/kg	
INORG	Selenium	SE	SOIL	American robin (Avian omnivore)	0.83	1.6	mg/kg	
INORG	Selenium	SE	SOIL	Deer mouse (Mammalian omnivore)	0.82	1.2	mg/kg	
INORG	Selenium	SE	SOIL	Earthworm (Soil-dwelling invertebrate)	4.1	41	mg/kg	
INORG	Selenium	SE	SOIL	Generic plant (Terrestrial autotroph - producer)	0.52	3	mg/kg	MINIMUM
INORG	Selenium	SE	SOIL	Gray fox (Mammalian top carnivore)	92	130	mg/kg	
INORG	Selenium	SE	SOIL	Montane shrew (Mammalian insectivore)	0.7	1	mg/kg	
INORG	Selenium	SE	SOIL	Mountain cottontail (Mammalian herbivore)	2.2	3.4	mg/kg	
INORG	Vanadium	V	SOIL	American kestrel (Avian top carnivore)	110	230	mg/kg	
INORG	Vanadium	V	SOIL	American kestrel (insectivore / carnivore)	56	110	mg/kg	
INORG	Vanadium	V	SOIL	American robin (Avian herbivore)	6.8	13	mg/kg	
INORG	Vanadium	V	SOIL	American robin (Avian insectivore)	4.7	9.5	mg/kg	MINIMUM

Table D-6 LANL Receptor-Specific Ecological Screening Levels *(continued/End)*

Analyte Group	Analyte Name	Analyte Code	ESL Medium	ESL Receptor	No Effect ESL	Low Effect ESL	Units	Minimum ESL
INORG	Vanadium	V	SOIL	American robin (Avian omnivore)	5.5	11	mg/kg	
INORG	Vanadium	V	SOIL	Deer mouse (Mammalian omnivore)	470	1000	mg/kg	
INORG	Vanadium	V	SOIL	Generic plant (Terrestrial autotroph - producer)	60	80	mg/kg	
INORG	Vanadium	V	SOIL	Gray fox (Mammalian top carnivore)	3200	6900	mg/kg	
INORG	Vanadium	V	SOIL	Montane shrew (Mammalian insectivore)	290	610	mg/kg	
INORG	Vanadium	V	SOIL	Mountain cottontail (Mammalian herbivore)	740	1500	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	American kestrel (Avian top carnivore)	2	20	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	American kestrel (insectivore / carnivore)	0.052	0.52	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	American robin (Avian herbivore)	0.38	3.8	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	American robin (Avian insectivore)	0.011	0.11	mg/kg	MINIMUM
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	American robin (Avian omnivore)	0.021	0.21	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	Deer mouse (Mammalian omnivore)	360	860	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	Generic plant (Terrestrial autotroph - producer)	160	600	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	Gray fox (Mammalian top carnivore)	62000	140000	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	Montane shrew (Mammalian insectivore)	180	450	mg/kg	
SVOC	Di-n-Butyl Phthalate	84-74-2	SOIL	Mountain cottontail (Mammalian herbivore)	17000	40000	mg/kg	

Notes: INORG = inorganic; SVOC = semi-volatile organic compound, VOC = volatile organic compound

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Attachment D-7

Area Use Factors

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Table D.7-1 Area Use Factors

Receptor	AUF (ha)[1]	AUF (acre)	PAUF (ha)[2]	PAUF (acre)	"HAB"* Unit-Specific PAUF based on Ac[3]	"HAB"* Unit- Specific PAUF based on Ha[3]
Earthworm (Soil-dwelling invertebrate)	NA	NA	NA	NA	1.00E+00	1.00E+00
American Kestrel (Avian top carnivore)	1.06E+02	2.62E+02	4.24E+03	1.05E+04	1.20E-01	3.00E-03
American Kestrel (insectivore / carnivore)	1.06E+02	2.62E+02	4.24E+03	1.05E+04	1.20E-01	3.00E-03
American Robin (Avian herbivore)	4.20E-01	1.04E+00	1.68E+01	4.15E+01	3.04E+01	7.56E-01
American Robin (Avian insectivore)	4.20E-01	1.04E+00	1.68E+01	4.15E+01	3.04E+01	7.56E-01
American Robin (Avian omnivore)	4.20E-01	1.04E+00	1.68E+01	4.15E+01	3.04E+01	7.56E-01
Deer Mouse (Mammalian omnivore)	7.70E-02	1.90E-01	3.00E+00	7.41E+00	1.66E+02	4.23E+00
Montane Shrew (Mammalian insectivore)	3.90E-01	9.64E-01	1.56E+01	3.85E+01	3.27E+01	8.14E-01
Mountain Cottontail (Mammalian herbivore)	3.10E+00	7.66E+00	1.24E+02	3.06E+02	4.11E+00	1.02E-01
Gray Fox (Mammalian top carnivore)	1.04E+03	2.56E+03	4.15E+04	1.03E+05	1.23E-02	3.06E-04

1 – Area Use Factor (AUF) or home range taken from Table 3.3-1 of LANL 2015 Screening Level Ecological Risk Assessment Methods, Revision 4
2 - Population Area Use Factor (PAUF) taken from Table 3.3-1 of LANL 2015 Screening Level Ecological Risk Assessment Methods, Revision 4
3 – Unit-specific AUF = Site size (acres) / AUF (acres) (ac)
4 – Unit-specific Population Area Use Factor (PAUF) = Site size (ha) / PAUF (ha)
Ac = acre; Ha = hectare; No receptor-specific RSVs are available for aluminum, Di-N-butylphthalate, or iron.

Unit Size	Hectare	Acre
"HAB" surrogate*	1.27E+01	3.15E+01

* As a conservative estimate, the size of the ash basins (FAL, HAB, KAB, LAB) for the population area use factor calculation is based on the largest unit, **HAB with a total area of ash within/outside of the basin = 12.7 ha (31.5 ac).** This maximizes the portion of the home range of the receptor that overlaps with the unit.

Unit Size	Hectare	Acre
"Remaining ash units" surrogate	1.27E+01	3.15E+01
ACPRB	1.10E+00	2.60E+00
AAP	6.00E-01	2.50E+00
FAL	2.80E+00	1.88E+01
HAB	1.27E+01	3.15E+01
KAB	4.50E+00	1.50E+01
LAB	7.10E+00	1.93E+01

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Attachment D-8

PAUF Adjusted Hazard Quotients

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Table D.8 PAUF-Adjusted HQs for Remaining Coal Ash and Coal Fines OU (Soil 0-1 ft)

Analyte[1]	Mean Concentration (mg/kg)[2]	RSV Source[3]	American Kestrel (Avian top carnivore) RSV	American Kestrel (Avian top carnivore) Adjusted HQ	American Kestrel (insectivore / carnivore) RSV	American Kestrel (insectivore / carnivore) Adjusted HQ	American Robin (Avian herbivore) RSV	American Robin (Avian herbivore) Adjusted HQ	American Robin (Avian insectivore) RSV	American Robin (Avian insectivore) Adjusted HQ
ARSENIC	2.52E+01	3	7.40E+03	1.02E-05	1.00E+03	7.55E-05	3.40E+02	5.60E-02	1.50E+02	1.27E-01
SELENIUM	2.21E+00	3	1.40E+02	4.73E-05	7.50E+00	8.83E-04	1.90E+00	8.80E-01	1.40E+00	1.19E+00
VANADIUM	2.56E+01	3	2.30E+02	3.34E-04	1.10E+02	6.98E-04	1.30E+01	1.49E+00	9.50E+00	2.04E+00

Table D.8. PAUF-Adjusted HQs for Remaining Coal Ash and Coal Fines OU (Soil 0-1 ft) *(continued)*

Analyte[1]	Mean Concentration (mg/kg)[2]	RSV Source[3]	American Robin (Avian omnivore) RSV	American Robin (Avian omnivore) Adjusted HQ	Deer mouse (Mammalian omnivore) RSV	Deer mouse (Mammalian omnivore) Adjusted HQ	Earthworm (Soil-dwelling invertebrate) RSV	Earthworm (Soil-dwelling invertebrate) Adjusted HQ
ARSENIC	2.52E+01	3	2.10E+02	9.07E-02	5.10E+01	2.09E+00	6.80E+01	3.70E-01
SELENIUM	2.21E+00	3	1.60E+00	1.05E+00	1.20E+00	7.80E+00	4.10E+01	5.40E-02
VANADIUM	2.56E+01	3	1.10E+01	1.76E+00	1.00E+03	1.09E-01	NA	NC

Table D.8. PAUF-Adjusted HQs for Remaining Coal Ash and Coal Fines OU (Soil 0-1 ft) (*END)*

Analyte[1]	Mean Concentration (mg/kg)[2]	RSV Source[3]	Gray Fox (Mammalian top carnivore) RSV	Gray Fox (Mammalian top carnivore) Adjusted HQ	Montane Shrew (Mammalian Insectivore) RSV	Montane Shrew (Mammalian Insectivore) Adjusted HQ	Mountain cottontail (Mammalian herbivore) RSV	Mountain cottontail (Mammalian herbivore) Adjusted HQ
ARSENIC	2.52E+01	3	1.30E+03	5.93E-06	3.10E+01	6.62E-01	1.80E+02	1.43E-02
SELENIUM	2.21E+00	3	1.30E+02	5.20E-06	1.00E+00	1.80E+00	3.40E+00	6.66E-02
VANADIUM	2.56E+01	3	6.90E+03	1.14E-06	6.10E+02	3.42E-02	1.50E+03	1.75E-03

Notes:
1 –COPCs identified in Table D-2 with receptor-specific RSVs available. Receptor-specific RSVs are not available for aluminum, Di-N-butylphthalate, iron, or radionuclides.
2 – Mean concentration from Appendix A Table A.1.1 (0-1 ft)
3 – Los Alamos National Laboratory Low Effect ESL for soil media (LANL 2022)
4 – Species-specific RSV for receptor from Attachment D-7
5 – PAUF-adjusted value: Hazard Quotient (HQ) = (Mean/RSV) x PAUF); PAUF = Size of Unit in ha/Population Size in ha

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Attachment D-9

Selected Ecological Studies Relating to Ash Units at the SRS

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SREL CCW Publications

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APPENDIX E

PRINCIPAL THREAT SOURCE MATERIAL EVALUATION

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LIST OF ABBREVIATIONS AND ACRONYMS

AAP	A-Area Ash Pile (788-A)
ac	acre(s)
ACPRB	A-Area Coal Pile Runoff Basin (788-3A)
COC	constituent of concern
EA	Early Action
EPC	exposure point concentration
FAL	F-Area Ash Landfill (288-F)
ft	feet
ha	hectare(s)
HAB	H-Area Ash Basin (288-H)
HI	hazard index
HQ	hazard quotient
KAB	K-Area Ash Basin (188-K)
LAB	L-Area Ash Basin (188-L)
LiDAR	light detection and ranging
m	meter
m^3	cubic meter
OU	Operable Unit
PRG	preliminary remediation goal
PTSM	principal threat source material
RCOC	refined constituent of concern
RSL	regional screening level
SCDES[1]	South Carolina Department Environmental Services
SRS	Savannah River Site
USEPA	U.S. Environmental Protection Agency
yd^3	cubic yards

[1] SCDES was known as the South Carolina Department of Health and Environmental Control prior to July 1, 2024.

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E-1. INTRODUCTION

The principal threat source material (PTSM) risk evaluation in support of the Focused Early Action (EA) Corrective Measures Study (CMS)/Feasibility Study (FS) for the remaining coal ash and coal fines Operable Units (OUs): A-Area Ash Pile (788-A) (AAP) and A-Area Coal Pile Runoff Basin (788-3A) (ACPRB) OU, F-Area Ash Landfill (288-F) (FAL) OU, H-Area Ash Basin (288-H) (HAB) OU, K-Area Ash Basin (188-K) (KAB) OU, and L-Area Ash Basin (188-L) (LAB) OU is presented in this appendix.

The concept of principal threat waste and low-level threat waste as developed by the U.S. Environmental Protection Agency (USEPA) in the National Contingency Plan (40 *Code of Federal Regulations* 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 to surface water, or air, or that act as a source for direct exposure (USEPA 1991).

The determination of whether the source materials present at a waste unit would be classified as PTSM is based mainly on the USEPA guidance document (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." These include liquids and other highly mobile materials (e.g., materials that 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 1E-03 or greater. According to USEPA, the PTSM concept expectation was to "help streamline and focus the remedy selection process, not as a mandatory waste classification requirement."

The USEPA, South Carolina Department Environmental Services (SCDES), and U.S. Department of Energy (USDOE) evaluated the USEPA guidance with respect to toxicity and contaminant migration analysis performed at Savannah River Site (SRS). In practice, SRS risk assessment and

contaminant migration evaluations identify constituents of concern (COCs) associated with source material or impacted media and determine the associated risk (i.e., adverse health impacts as measured by the hazard index [HI] and numerical estimate of risk) or potential impact to environmental media. If threshold risk levels are exceeded, 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 reevaluation is needed to account for potentially highly toxic source material or contaminated soils at depth that would results in unacceptable risk should exposure occur. Therefore, a quantitative determination of whether contamination exists above PTSM levels at the remaining coal ash and coal fines operable units (OUs) was performed.

E-1.1 Background

The remaining coal ash and coal fines OUs consist of five individual OUs as discussed in the following sections. A detailed description of each OU is provided in Chapters 1 and 2.

E-1.1.1 A-Area Ash Pile (778-A) and A-Area Coal Pile Runoff Basin (788-3A) Operable Unit

The AAP contains bottom ash and fly ash received from the A-Area Boiler House (784-A) between 1952 and 1978. During operation of the AAP, the pile was graded, the top leveled, and the north side (stream side) benched. The AAP encompasses 0.65 hectares (ha) (1.60 acres [ac]). The ash within the AAP extends northward towards the edge of an unnamed tributary to Tims Branch. The total area of ash, including ash outside the boundary, is approximately (~)1.03 ha (2.55 ac). The total volume of ash is ~53,519 m^3 (70,000 yd^3). The depth of ash is variable with the average depth of ~5.0 m (17.0 ft). Figure E-1 shows the boundary of the AAP and the extent of ash.

The ACPRB was constructed in 1978 and operated until closure of the A-Area Boiler House (784-A) in 2008. Runoff from the coal storage pile was collected/transported in ditches and underground pipes that discharged to the ACPRB. The ACPRB covers ~ 1.06 ha (2.62 ac). The approximate total volume of coal fines is 7,645 m^3 (10,000 yd^3). The average depth of coal fines within the ACPRB is ~0.7 m (2.4 ft). Figure E-2 shows the boundary of the ACPRB.

E-1.1.2 F-Area Ash Landfill (288-F) Operable Unit

The FAL OU is an active Class II Landfill (SCDES Solid Waste Landfill Permit #025800-1601). The FAL OU consists of the active landfill and the area outside the landfill boundary where ash deposits are known to exist. The FAL OU became operational in 1954 and received ash from the A-, F-, and H-Area powerhouses during its operational history. The interior of the landfill is ~2.84 ha (7.01 ac). As of August 2023, the volume of ash within the FAL OU was calculated to be ~151,458 m^3 (198,099 yd^3). Additional ash outside of the landfill is estimated to have an area of 4.64 ha (11.47 ac) and a volume of 11,744 m^3 (15,360 yd^3). The total area of ash is ~7.48 ha (18.48 ac) and the total volume of ash at the FAL OU is ~163,201 m^3 (213,459 yd^3). The depth of ash is variable with an average depth of ~9.8 m (32.0 ft). Figure E-3 shows the OU boundary of the FAL OU and the extent of ash.

E-1.1.3 H-Area Ash Basin (288-H) Operable Unit

The HAB OU received ash via sluice of wet ash slurry from the H-Area Powerhouse (284-H). The coal-fired powerhouse operated from 1950 to 1990. The HAB OU includes wet soils within and beyond the boundary of the OU. A known/suspected Carolina Bay is partially located within the southeastern boundary of the OU where standing water is frequently encountered. In 1993 to 1994, ~ 76,455 m^3 (100,000 yd^3) of ash was removed from the basin and transported to the FAL OU and F-Area Ash Basin (288-1F). The area of the HAB OU is ~5.29 ha (13.06 ac). The volume of ash within the boundary is ~84,944 m^3 (111,103 yd^3). Additional ash outside of the basin boundary is estimated to have an area of ~7.45 ha (18.40 ac) and a volume of 113,161 m^3 (148,009 yd^3). The total area of ash within and outside of the basin boundary is ~12.73 ha (31.46 ac). The total volume of ash inside and outside the basin boundary is ~198,105 m^3 (259,112 yd^3). The depth of ash is variable with an average depth of ~3.6 m (12.0 ft). Figure E-4 shows the OU boundary of the HAB OU and the extent of ash.

E-1.1.4 K-Area Ash Basin (188-K) Operable Unit

The KAB OU received ash from the K-Area Powerhouse (184-K) via wet sluice. The coal-fired powerhouse operated from 1951 to 1990. The area of the basin is ~ 4.52 ha (11.16 ac). The volume of ash within the boundary is ~194,627 m^3 (254,563 yd^3). Additional ash outside of the basin boundary is estimated to be 1.54 ha (3.81 ac) with a volume of 13,734 m^3 (17,964 yd^3). The total

area of ash inside and outside the basin is ~6.06 ha (14.97 ac). The total volume of ash inside and outside the basin boundary is ~208,362 m^3 (272,527 yd^3). The depth of ash is variable with an average depth of ~4.5 m (15.0 ft). Figure E-5 shows the OU boundary for the KAB OU and the extent of ash.

E-1.1.5 L-Area Ash Basin (188-L) Operable Unit

The LAB OU received ash from the L-Area Powerhouse (184-L) via wet sluice. The coal-fired powerhouse operated from 1951 to 1968. The interior area of the basin is ~ 7.13 ha (17.61 ac), with a volume of ash within the boundary of ~233,189 m^3 (305,000 yd^3). Additional ash outside of the basin boundary is estimated to have an area of 0.68 ha (1.67 ac) and a volume of ~13,781 m^3 (18,026 yd^3). The total area of ash within and outside of the basin boundary is ~7.80 ha (19.28 ac). The total volume of ash inside and outside the basin boundary is ~246,971 m^3 (323,026 yd^3). The depth of ash is variable with an average depth of ~3.3 m (11.0 ft). Figure E-6 shows the OU boundary for the LAB OU and the extent of ash.

E-1.2 Data

Characterization activities for the remaining coal ash and coal fines OUs are described in detail in Chapter 3. The five OUs were placed in two groups based on unit type, quantity of available data, and level of data assessment as described below.

AAP and ACPRB OU

The AAP and ACPRB OU were investigated under a previous remedial investigation and documented in the *RFI/RI Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measure Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit* (SRNS 2012). Therefore, the results of the previous baseline risk assessment are included as part of this PTSM evaluation in support of the Focused EA Corrective Measure Study/FS process.

FAL, HAB, KAB, and LAB OUs

Due to the consistency with other ash waste unit risk evaluations that have been performed in the past, including OUs that have gone through a formal BRA process, such as the AAP and ACPRB OU (Table E-1), the USEPA, SCDES, and USDOE agreed at the Focused EA CMS/FS Scoping Meeting in November 2023 (SRNS 2023a), that the data from the HAB, KAB, and LAB OUs would be combined into one dataset for data processing in accordance with the approved protocols in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2023b).

The Core Team, USEPA, SCDES, and USDOE, also agreed during the Focused EA CMS/FS Scoping Meeting in November 2023 that the results of the risk assessment for the HAB, KAB, and LAB OUs would apply to the FAL OU (SRNS 2023a).

Appendix A presents the maximum detected constituent concentrations and activity concentrations from the HAB, KAB, and LAB OUs (Table A.1) that are used in the PTSM evaluation. The only interval that was sampled at the three OUs was from the 0 to 0.3 m (0 to 1 ft) ash/soil interval.

E-1.3 Receptor

The *industrial worker* scenario (termed composite worker) is a standard USEPA exposure scenario which addresses long-term risks to workers who are exposed to the on-unit contaminants within an industrial setting. This receptor scenario is evaluated under this PTSM evaluation for the remaining coal ash and coal fines OUs. The principal exposure assumptions for the industrial worker are 25 years, 250 days per year, and 8 hours per day. Given the current and expected future land use of the area in which the remaining coal ash and coal fines OUs are located, the industrial worker is the most likely receptor exposure scenario.

E-1.4 Sources of Risk-Based Threshold Values

The USEPA publishes regional screening levels (RSLs) for nonradiological constituents and preliminary remediation goals (PRGs) for radiological constituents that are risk-based concentrations (or activity concentrations) that can be used to evaluate potentially contaminated waste sites. Both RSLs and PRGs combine current USEPA toxicity values with standard exposure

factors that represent reasonable maximum exposure (RME) conditions to estimate contaminant concentrations in exposure media that the agency considers protective of humans over a lifetime. The concentrations are based on direct exposure pathways for which generally accepted methods, models, and assumptions have been developed for specific land use conditions.

The USEPA *Regional Screening Levels* website (USEPA 2024a) is the source of risk-based threshold values for nonradiological constituents used in this evaluation. The website was accessed in June 2024. The industrial worker regional screening levels RSLs are provided in Attachment E-1.

The USEPA *Preliminary Remediation Goals for Radionuclides at Superfund Sites* website (USEPA 2024b) is the source of the radionuclide threshold values used in this evaluation. The website was accessed in June 2024. The industrial worker preliminary remediation goals (PRGs) are provided in Attachment E-2.

E-2. PTSM EVALUATION PROCESS

To determine whether contaminated source material/soils should be preliminarily considered PTSM, a simple quantitative assessment evaluating the toxicity of the source is used where the results are compared to a threshold for determining PTSM.

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 effects from noncarcinogens to an industrial worker receptor. The source material (i.e., soil) is preliminarily considered to be PTSM if the cumulative risk exceeds at least one of the following threshold screening criteria:

- Carcinogens – greater than 1E-03 industrial worker risk
- Noncarcinogens – industrial worker HI greater than 10

In the preliminary screen, the unit maximum concentration for every detected constituent for the soil media from the all-depths interval from each of the subunits in the remaining coal ash and coal fines OUs is determined and used as the exposure point concentration (EPC).

For carcinogens, the individual risk associated with each constituent is calculated by multiplying the ratio of the EPC to the RSL or PRG by 1E-06. Each of these risks is summed to calculate the cumulative carcinogenic risk associated with the source. For noncarcinogens, a hazard quotient (HQ) associated with each constituent is calculated by dividing the EPC by the RSL. These HQs are summed to derive the cumulative HI. If neither threshold criteria for PTSM are exceeded based on the maximum detected concentrations and activity concentrations, then PTSM is not present, and it is not necessary to evaluate further. If the threshold criteria are exceeded, then an uncertainty analysis may be conducted to further evaluate the constituents and source(s) that exceed the PTSM toxicity criteria.

E-2.1 Screening Evaluation

For the screening evaluation for PTSM, maximum concentrations for nonradiological constituents and activity concentrations for radionuclides in soil (all depths), as appropriate, from the remaining coal ash and coal fines OUs was used to calculate HQs for noncarcinogens and numerical risk for carcinogens. The following equations are used to calculate HQs and risks for the PTSM evaluation:

$$noncarcinogen\ hazard\ quotient = \frac{[Maximum\ Concentration]}{[RSL]}$$

$$carcinogen\ risk\ estimate = \left(\frac{[Maximum\ Concentration]}{[RSL\ or\ PRG]}\right) \times 1E\text{-}06$$

E-2.2 Results

E-2.2.1 AAP and ACPRB OU

The PTSM screening evaluation for the AAP and ACPRB OU is described in the *Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation Work Plan and RFI/ RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit* (SRNS 2012). Results of the PTSM evaluation at the AAP specify that the HI is 1.60E+00 and the cumulative risk is 3.53E-05. Results of the PTSM evaluation for at the ACPRB indicate that the HI is 2.00E+00 and the cumulative risk is 1.42E-04. No PTSM refined constituents of concern (RCOCs) are identified for the AAP and ACPRB OU.

E-2.2.2 FAL, HAB, KAB, and LAB OUs

Table E-1 presents the results of the PTSM screening evaluation at the FAL, HAB, KAB and LAB OUs. Results of the PTSM evaluation indicate that the HI is 2.83E-01 and the cumulative risk is 8.07E-04. No PTSM RCOCs are identified for the FAL, HAB, KAB and LAB OUs.

E-3. SUMMARY AND CONCLUSIONS

Based on the results of the PTSM evaluation, no PTSM RCOCs are identified for the remaining coal ash and coal fines OUs. The revised conceptual site model is presented in Figures 15 through 21.

Summary of the Remaining Coal Ash and Coal Fines OUs PTSM Assessment

OU	PTSM RCOCs
AAP and ACPRB	Ash/Soil None
FAL, HAB, KAB, and LAB	Ash/Soil None

E-4. REFERENCES

SRNS, 2012. Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan and RFI/RI Report with Baseline Risk Assessment and Corrective Measures Study/Feasibility Study for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), and Stormwater Outfall A-013 (NBN) Operable Unit, SRNS-RP-2010-01457, Revision 1, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2023a. *Scoping Summary for the A-Area Ash Pile (788-A), A-Area Coal Pile Runoff Basin (788-3A), F-Area Ash Landfill (288-F), H-Area Ash Basin (288-H), K-Area Ash Basin (188-K), and L-Area Ash Basin (188-L) in Support of Beneficial Reuse of Select Coal Ash and Coal Fines Operable Units at the Savannah River Site*, SRNS-RP-2023-00858, Revision 0, November 2023, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC.

SRNS, 2023b. *Environmental Compliance and Area Completion Project Regulatory Document Handbook*, SRNS-RP-2022-00330, Revision 0, June 2023, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC.

USEPA, 1991. *A Guide to Principal Threat and Low-Level Threat Wastes*, Superfund Publication 9380.3-06FS, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

USEPA, 2024a. *USEPA Regional Screening Levels,* U.S. Environmental Protection Agency, National Center for Environmental Assessment, Arlington, VA, accessed June 2024, https://www.epa.gov/risk/regional-screening-levels-rsls

USEPA, 2024b. *USEPA Preliminary Remediation Goals for Radionuclides at Superfund Sites,* U.S. Environmental Protection Agency, Office of Land and Emergency Management, Washington, DC, accessed June 2024, https://epa-prgs.ornl.gov/radionuclides

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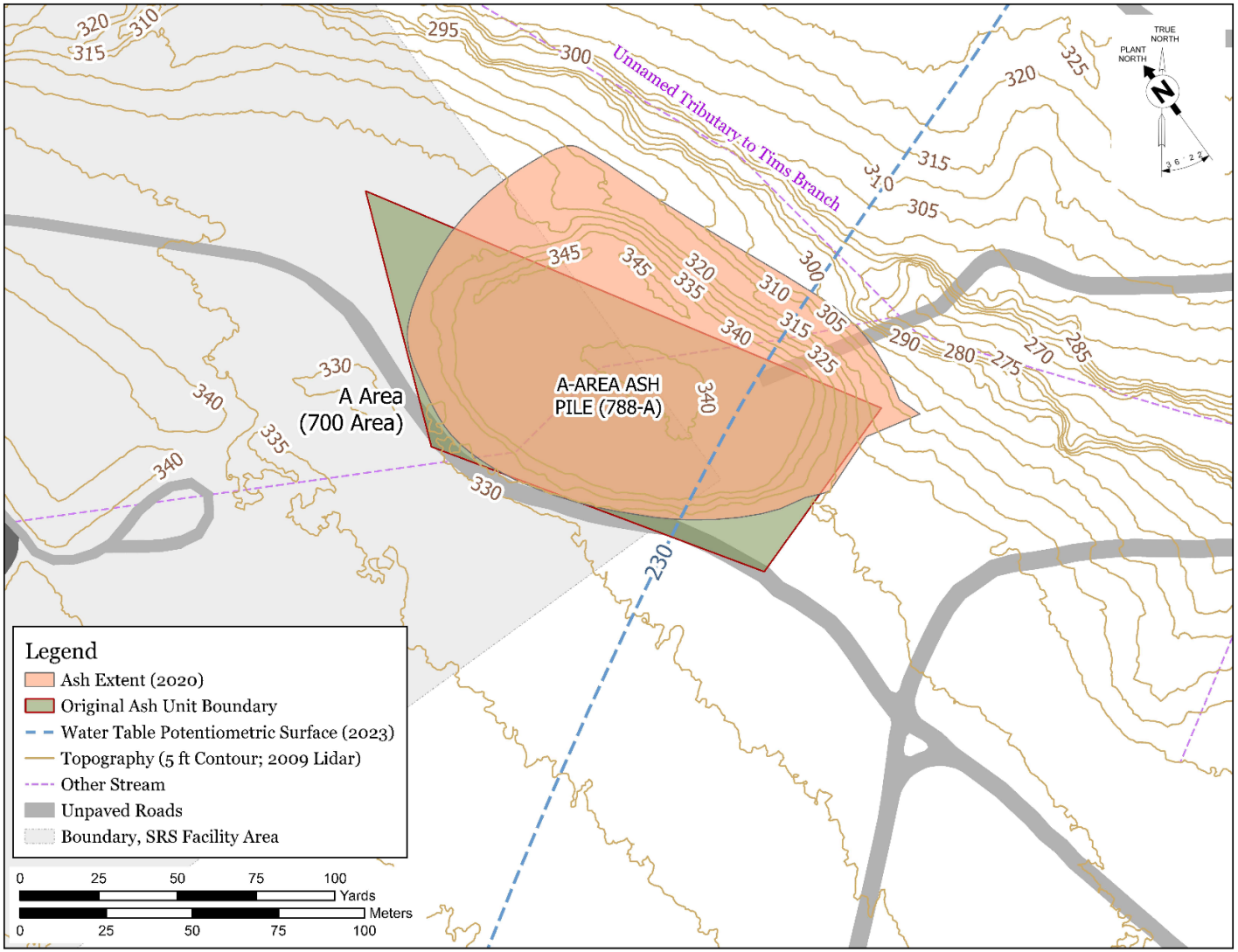


Figure E-1. AAP Unit Boundary and Ash Extent

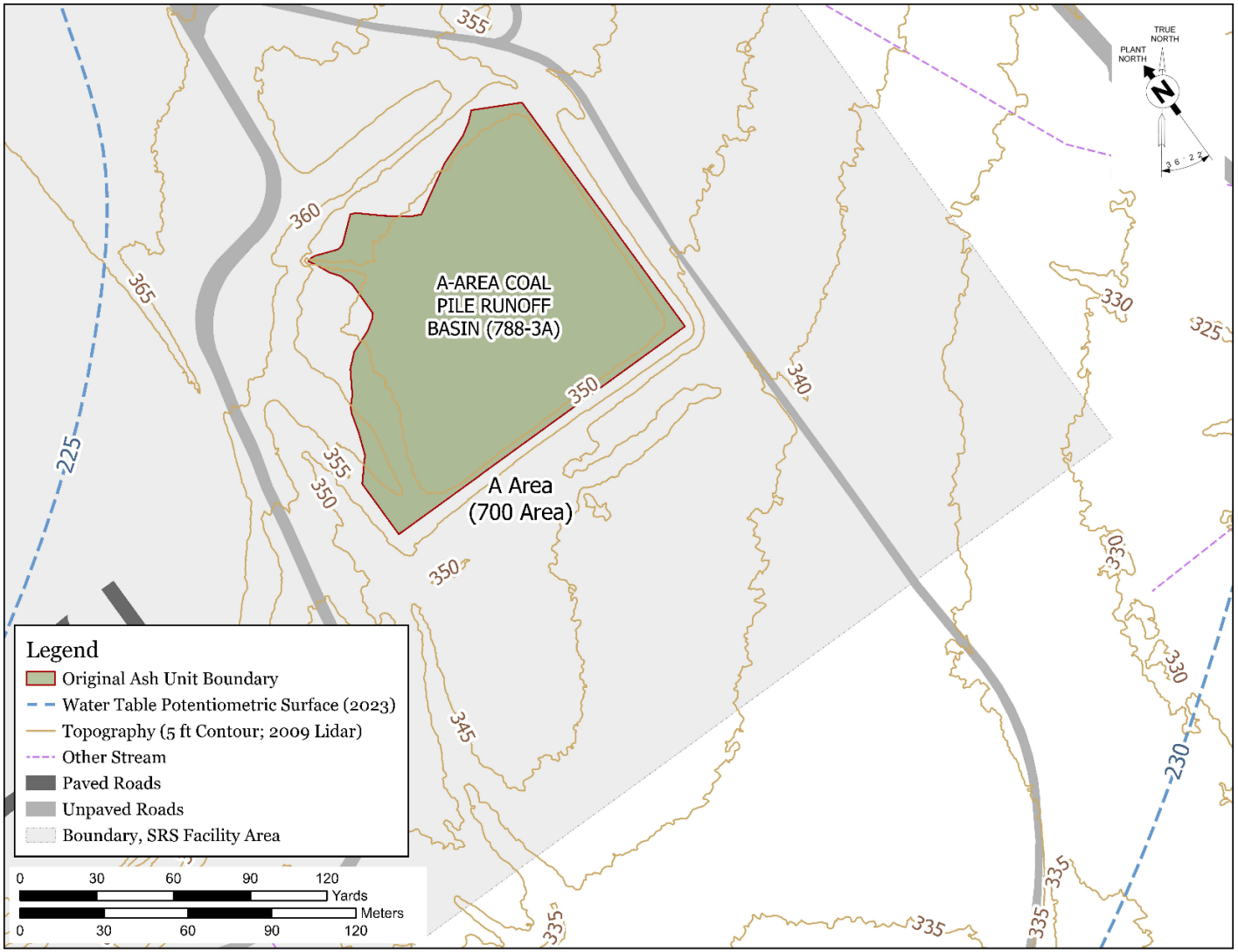


Figure E-2. ACPRB Unit Boundary

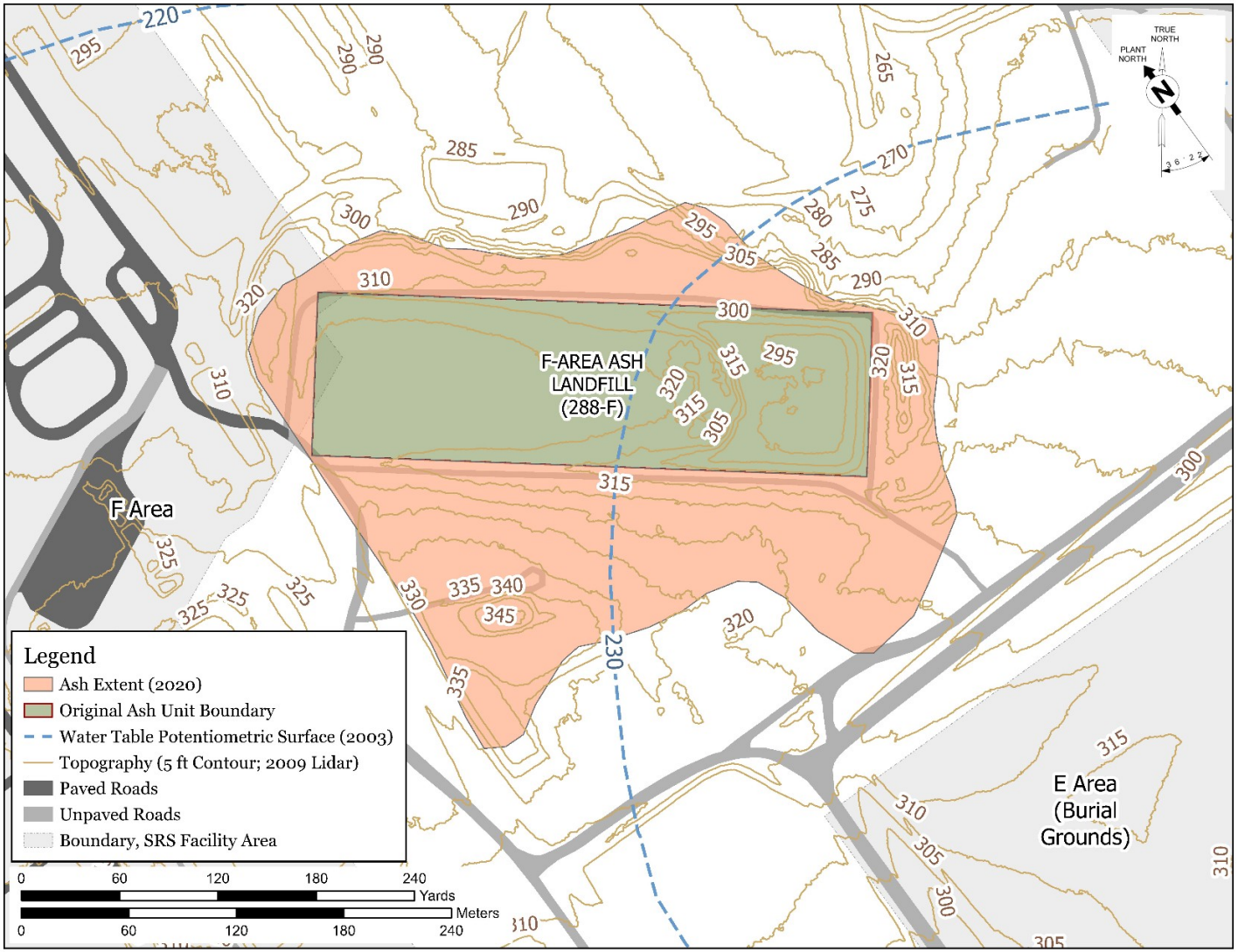


Figure E-3. FAL Unit Boundary and Ash Extent

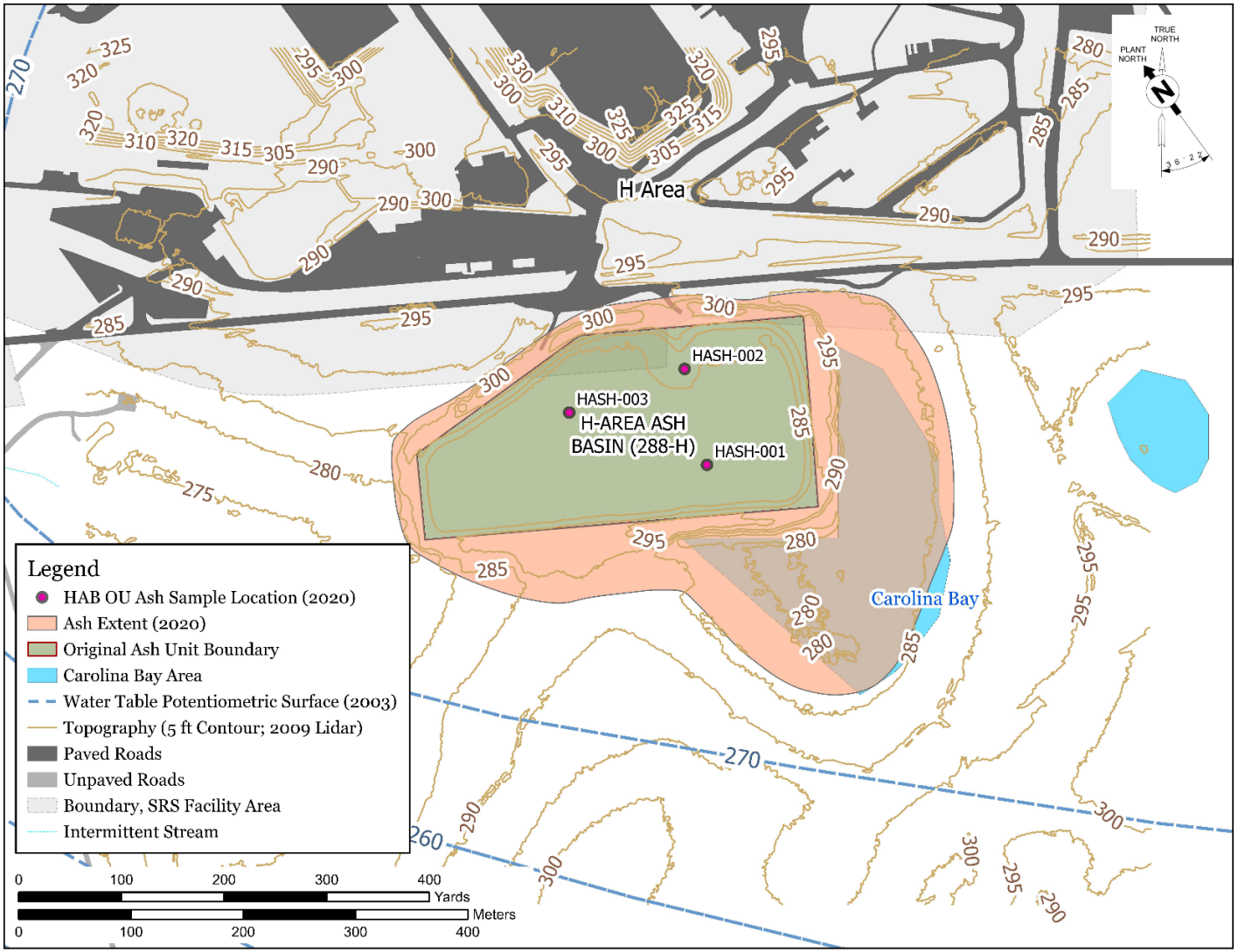


Figure E-4. HAB Unit Boundary and Ash Extent

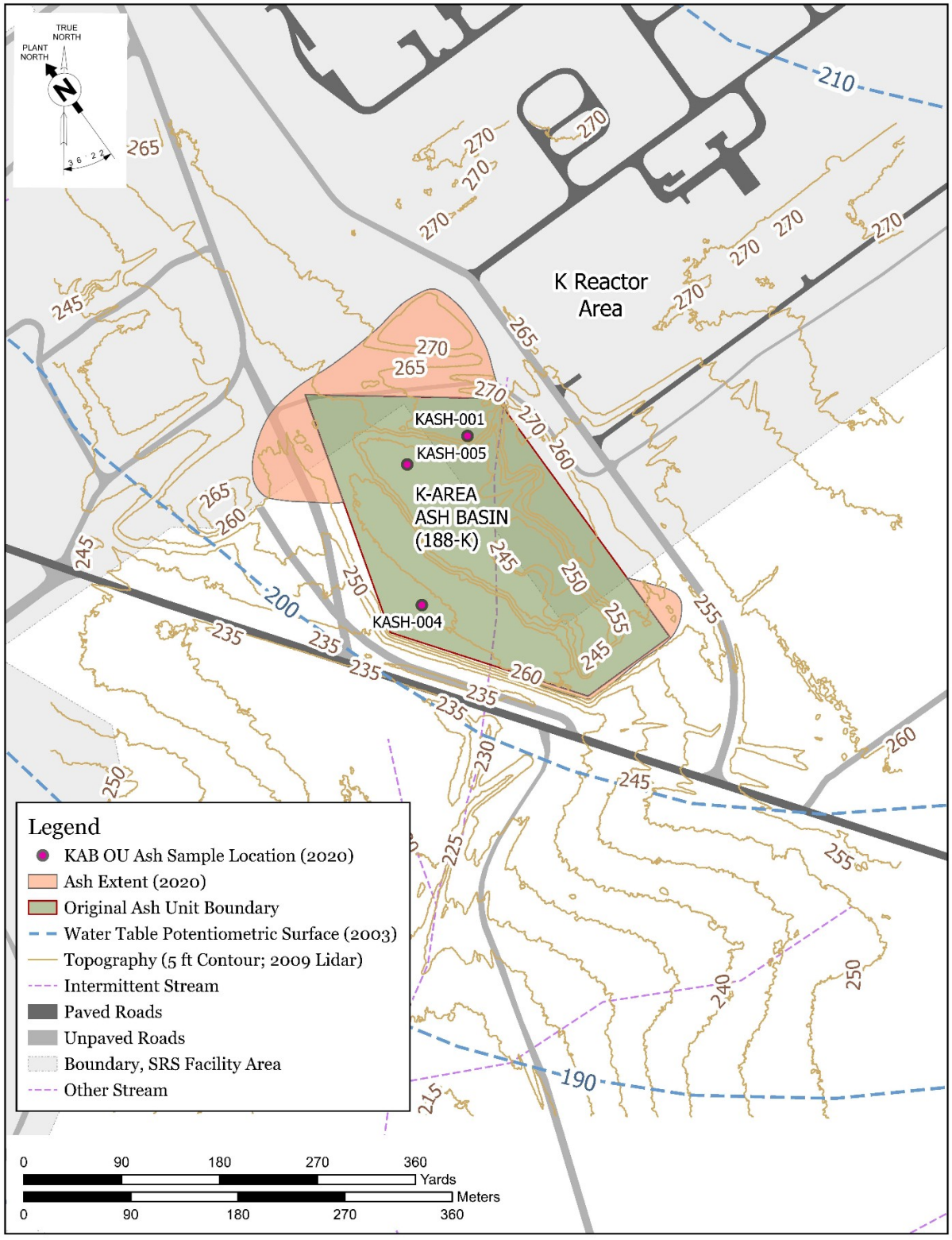


Figure E-5. KAB Unit Boundary and Ash Extent

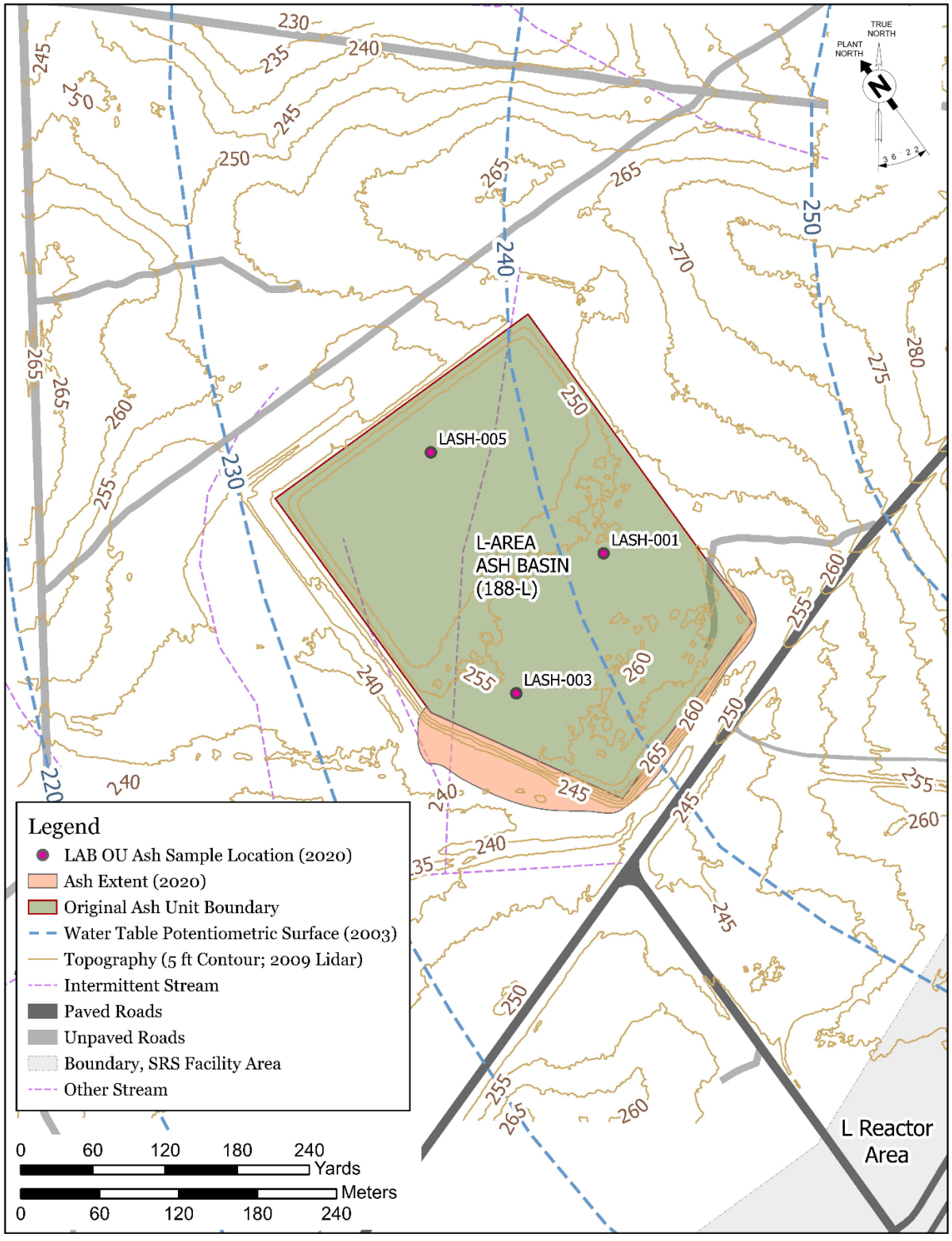


Figure E-6. LAB Unit Boundary and Ash Extent

Table E-1. PTSM Screening Evaluation for FAL, HAB, KAB, and LAB

Analyte	Exposure Point Concentration[1]	Noncarcinogenic Hazard Estimate		Carcinogenic Risk Estimate	
		Industrial RSL[2,5]	Industrial HQ Estimate[3]	Industrial RSL/PRG[2,5,6]	Industrial Risk Estimate[4]
Inorganics *(mg/kg)*					
ALUMINUM	2.16E+04	1.12E+06	1.93E-02	NA	--
ARSENIC	7.65E+01	4.79E+02	1.60E-01	3.00E+00	2.55E-05
BARIUM	4.79E+02	2.17E+05	2.21E-03	NA	--
BERYLLIUM	5.06E+00	2.29E+03	2.21E-03	6.95E+03	7.28E-10
CALCIUM	4.59E+04	EN	--	EN	--
CHROMIUM	1.87E+01	3.48E+03	5.37E-03	6.33E+00	2.95E-06
COBALT	1.01E+01	3.47E+02	2.91E-02	1.85E+03	5.46E-09
COPPER	3.90E+01	4.67E+04	8.35E-04	NA	--
IRON	2.16E+04	8.18E+05	2.64E-02	NA	--
LEAD	1.25E+01	8.00E+02	1.56E-02	NA	--
MAGNESIUM	5.44E+03	EN	--	EN	--
MANGANESE	2.30E+02	2.56E+04	8.98E-03	NA	--
MERCURY	1.03E-01	4.56E+01	2.26E-03	NA	--
NICKEL	1.55E+01	1.68E+04	9.12E-04	6.41E+04	2.42E-10
POTASSIUM	1.95E+03	EN	--	EN	--
SELENIUM	3.09E+00	5.84E+03	5.29E-04	NA	--
SODIUM	5.92E+02	EN	--	EN	--
VANADIUM	4.88E+01	5.83E+03	8.37E-03	NA	--
ZINC	2.67E+01	3.50E+05	7.63E-05	NA	--
Organics *(mg/kg)*					
2-METHYLNAPHTHALENE	4.15E-01	3.01E+03	1.38E-04	NA	--
BENZO(G,H,I)PERYLENE	2.97E-02	NA	--	NA	--
BENZO[A]ANTHRACENE	3.26E-02	NA	--	2.06E+01	1.58E-09
BENZO[A]PYRENE	1.52E-02	2.22E+02	6.85E-05	2.11E+00	7.20E-09
BENZO[B]FLUORANTHENE	3.75E-02	NA	--	2.11E+01	1.78E-09
BIS(2-ETHYLHEXYL)PHTHALATE (DEHP)	1.65E-02	1.64E+04	1.01E-06	1.64E+02	1.01E-10
CHRYSENE	3.51E-02	NA	--	2.11E+03	1.66E-11
DI-N-BUTYL PHTHALATE	2.46E-02	8.21E+04	3.00E-07	NA	--
FLUORANTHENE	4.97E-02	3.01E+04	1.65E-06	NA	--
INDENO[1,2,3-CD]PYRENE	1.30E-02	NA	--	2.11E+01	6.16E-10
NAPHTHALENE	2.60E-01	5.85E+02	4.44E-04	8.57E+00	3.03E-08
PHENANTHRENE	2.28E-01	NA	--	NA	--
PYRENE	6.42E-02	2.26E+04	2.84E-06	NA	--

Table E-2. PTSM Screening Evaluation for FAL, HAB, KAB, and LAB *(continued/end)*

Analyte	Exposure Point Concentration[1]	Noncarcinogenic Hazard Estimate		Carcinogenic Risk Estimate	
		Industrial RSL[2,5]	Industrial HQ Estimate[3]	Industrial RSL/PRG[2,5,6]	Industrial Risk Estimate[4]
***Radionuclides** (pCi/g)*					
CESIUM-137	2.26E-01	NA	--	9.07E-02	2.49E-06
POTASSIUM-40	1.25E+01	NA	--	2.19E-01	5.71E-05
THORIUM-232	3.90E+00	NA	--	1.53E-02	--
RADIUM-228	1.10E+00	NA	--	1.53E-02	--
ACTINIUM-228	4.15E+00	NA	--	1.53E-02	--
THORIUM-228	4.27E+00	NA	--	1.53E-02	2.80E-04
LEAD-212	3.55E+00	NA	--	1.53E-02	--
BISMUTH-212	4.23E+00	NA	--	1.53E-02	--
THALLIUM-208	1.04E+00	NA	--	1.53E-02	--
URANIUM-238	5.82E+00	NA	--	2.00E-02	--
URANIUM-233/234	6.72E+00	NA	--	2.00E-02	--
THORIUM-230	8.02E+00	NA	--	2.00E-02	--
RADIUM-226	8.63E+00	NA	--	2.00E-02	4.32E-04
LEAD-214	6.26E+00	NA	--	2.00E-02	--
BISMUTH-214	5.57E+00	NA	--	2.00E-02	--
URANIUM-235	5.61E-01	NA	--	7.31E-02	7.67E-06
		Hazard Index	2.83E-01	**Cumulative Risk**	8.07E-04
		PTSM?[7]	no	**PTSM?[8]**	no

1 - EPC - maximum detected concentration from 0 to 0.3 m (0 to 1 ft) interval, ash/soil media from Table A.1 in Appendix A.

2 - Nonradiological RSLS are industrial soil default values from the generic USEPA Regional Screening Levels (RSLs) website, accessed June 2024 (see Attachment C-1). Radiological PRGs are industrial soil default values from the generic USEPA Radionuclide Preliminary Remediation Goals (PRGs) for Superfund website, accessed June 2024 (see Attachment C-2).

3 - Industrial Hazard Estimate = EPC/RSL

4 - Industrial Risk Estimate = (EPC/[RSL or PRG])*1E-06

5 - RSL for hexavalent chromium (most conservative) used.

6 - For radionuclides within a decay chain (i.e., thorium-232, uranium-235, uranium-238) the most conservative EPC (highest activity) within each series is used to estimate the risk. Risk is calculated using parent PRG.

7 - Waste unit potentially has PTSM if HI ≥ 10 for noncarcinogenic constituents.

8 - Waste unit potentially has PTSM if cumulative risk ≥ 1E-03 for carcinogenic constituents.

EN - essential nutrient

NA - not available

Attachment E-1

USEPA Regional Screening Levels Website: Default Regional Screening Levels (RSLs) for Composite Worker (i.e., Industrial Worker) Scenario

Website accessed June 2024

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Default Regional Screening Levels (RSLs) for Composite Worker (i.e., Industrial Worker) Scenario

Contaminant	Carcinogenic TR = 1E-06				Noncarcinogenic HI=1			
Analyte	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL THQ=1 (mg/kg)	Dermal SL THQ=1 (mg/kg)	Inhalation SL THQ=1 (mg/kg)	Noncarcinogenic THQ=1 (mg/kg)
Inorganics								
ALUMINUM	-	-	-	NA	1.17E+06	-	2.98E+07	1.12E+06
ARSENIC	3.63E+00	1.72E+01	3.88E+03	3.00E+00	5.84E+02	2.76E+03	8.93E+04	4.79E+02
BARIUM	-	-	-	NA	2.34E+05	-	2.98E+06	2.17E+05
BERYLLIUM	-	-	6.95E+03	6.95E+03	2.34E+03	-	1.19E+05	2.29E+03
CALCIUM	-	-	-	NA	-	-	-	NA
CHROMIUM	6.54E+00	-	1.98E+02	6.33E+00	3.50E+03	-	5.95E+05	3.48E+03
COBALT	-	-	1.85E+03	1.85E+03	3.50E+02	-	3.57E+04	3.47E+02
COPPER	-	-	-	NA	4.67E+04	-	-	4.67E+04
CYANIDE	-	-	-	NA	7.01E+02	-	1.87E+02	1.47E+02
IRON	-	-	-	NA	8.18E+05	-	-	8.18E+05
LEAD	-	-	-	NA	-	-	-	8.00E+02
MAGNESIUM	-	-	-	NA	-	-	-	NA
MANGANESE	-	-	-	NA	2.80E+04	-	2.98E+05	2.56E+04
MERCURY	-	-	-	NA	-	-	4.56E+01	4.56E+01
NICKEL	-	-	6.41E+04	6.41E+04	2.34E+04	-	8.34E+04	1.68E+04
POTASSIUM	-	-	-	NA	-	-	-	NA
SELENIUM	-	-	-	NA	5.84E+03	-	1.19E+08	5.84E+03
SODIUM	-	-	-	NA	-	-	-	NA
VANADIUM	-	-	-	NA	5.89E+03	-	5.95E+05	5.83E+03
ZINC	-	-	-	NA	3.50E+05	-	-	3.50E+05

Default Regional Screening Levels (RSLs) for Composite Worker (i.e., Industrial Worker) Scenario *(continued)*

Contaminant	Carcinogenic TR = 1E-06				Noncarcinogenic HI=1			
Analyte	Ingestion SL TR=1E-06 (mg/kg)	Dermal SL TR=1E-06 (mg/kg)	Inhalation SL TR=1E-06 (mg/kg)	Carcinogenic SL TR=1E-06 (mg/kg)	Ingestion SL THQ=1 (mg/kg)	Dermal SL THQ=1 (mg/kg)	Inhalation SL THQ=1 (mg/kg)	Noncarcinogenic THQ=1 (mg/kg)
Organics								
2-METHYLNAPHTHALENE	-	-	-	NA	4.67E+03	8.49E+03	-	3.01E+03
BENZO(G,H,I)PERYLENE	-	-	-	NA	-	-	-	NA
BENZO[A]ANTHRACENE	3.27E+01	5.94E+01	8.99E+02	2.06E+01	-	-	-	NA
BENZO[A]PYRENE	3.27E+00	5.94E+00	2.78E+04	2.11E+00	3.50E+02	6.37E+02	1.19E+04	2.22E+02
BENZO[B]FLUORANTHENE	3.27E+01	5.94E+01	2.78E+05	2.11E+01	-	-	-	NA
BIS(2-ETHYLHEXYL)PHTHALATE (DEHP)	2.34E+02	5.52E+02	6.95E+06	1.64E+02	2.34E+04	5.52E+04	-	1.64E+04
CHRYSENE	3.27E+03	5.94E+03	2.78E+07	2.11E+03	-	-	-	NA
DI-N-BUTYL PHTHALATE	-	-	-	NA	1.17E+05	2.76E+05	-	8.21E+04
FLUORANTHENE	-	-	-	NA	4.67E+04	8.49E+04	-	3.01E+04
INDENO[1,2,3-CD]PYRENE	3.27E+01	5.94E+01	2.78E+05	2.11E+01	-	-	-	NA
NAPHTHALENE	2.73E+01	4.95E+01	1.67E+01	8.57E+00	2.34E+04	4.25E+04	6.09E+02	5.85E+02
PHENANTHRENE	-	-	-	NA	-	-	-	NA
PYRENE	-	-	-	NA	3.50E+04	6.37E+04	-	2.26E+04

Attachment E-2

USEPA Radionuclide Preliminary Remediation Goals for Superfund Website: Default Preliminary Remediation Goals (PRGs) for Composite Worker (i.e., Industrial Worker) Scenario

Website accessed June 2024

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Default Preliminary Remediation Goals (PRGs) for Composite Worker (i.e., Industrial Worker) Scenario

Radionuclide		Isotope-specific Information		PRG
Element (Atomic Number)	Isotope	Lambda (1/yr)	Half-life (yr)	Composite Worker Soil Total PRG TR=1E-06 (pCi/g)
Cesium (55)	Cesium-137	2.30E-02	3.02E+01	9.07E-02
Potassium (19)	Potassium-40	5.54E-10	1.25E+09	2.19E-01
Thorium (90)	Thorium-232	4.93E-11	1.41E+10	1.53E-02
Uranium (92)	Uranium-235	9.84E-10	7.04E+08	7.31E-02
Uranium (92)	Uranium-238	1.55E-10	4.47E+09	2.00E-02

PRG – preliminary remediation goals

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APPENDIX F

RISK-BASED CLEANUP LEVEL CALCULATIONS

PRELIMINARY REMEDIATION GOALS

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Table F-1. Human Health Risk-Based Preliminary Remediation Goals for the Remaining Coal Ash and Coal Fines OUs 7

LIST OF ABBREVIATIONS AND ACRONYMS

AAP	A-Area Ash Pile (788-A)
ACPRB	A-Area Coal Pile Runoff Basin (788-3A)
ARAR	applicable or relevant and appropriate requirement
CM	contaminant migration
CMS	corrective measures study
FAL	F-Area Ash Landfill (288-F)
FS	feasibility study
HAB	H-Area Ash Basin
HH	human health
HQ	hazard quotient
KAB	K-Area Ash Basin
LAB	L-Area Ash Basin
OU	operable unit
PRG	preliminary remediation goal
PTSM	principal threat source material
RCOC	refined constituent of concern
RSL	regional screening levels
USEPA	U.S. Environmental Protection Agency

F-1. INTRODUCTION

Risk-based cleanup levels, i.e., preliminary remediation goals (PRGs) for the Focused Early Action (EA) Corrective Measures Study (CMS)/Feasibility Study (FS) for the remaining coal ash and coal fines Operable Units (OUs): A-Area Ash Pile (788-A) (AAP) and A-Area Coal Pile Runoff Basin (788-3A) (ACPRB) Operable Unit (OU), F-Area Ash Landfill (288-F) (FAL) OU, H-Area Ash Basin (288-H) (HAB) OU, K-Area Ash Basin (188-K) (KAB) OU, and L-Area Ash Basin (188-L) (LAB) OU are presented in this appendix.

F-2. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS PRGS

As presented in the Remedial Investigation (Chapter 3), there are no applicable or relevant and appropriate requirements (ARARs) refined constituents of concern (RCOCs) identified for the remaining coal ash and coal fines OUs. Therefore, no ARAR PRGs are presented in this appendix.

F-3. CONTAMINANT MIGRATION PRGS

The contaminant migration (CM) analysis is presented in Appendix B of this document. There were CM RCOCs identified for the HAB OU (barium, uranium-233/234, uranium-235, and uranium-238) and the LAB OU (barium). CM PRGs are presented in Table B-15 of Appendix B.

F-4. HUMAN HEALTH PRGS

The human health (HH) risk assessment is presented in Appendix C of this document. HH RCOCs were identified in the remaining coal ash and coal fines OUs for arsenic, and naturally occurring radionuclides (potassium-40, thorium-232, and uranium-238). Radium-226 was identified as a HH RCOC for the AAP; however, radium-226 is a daughter product of the uranium-238 decay series and will be managed under the cleanup level established for the entire decay series.

Risk-based PRGs are based on the regional screening levels presented in Appendix C and are calculated for the residential and industrial worker exposure scenarios at a hazard quotient (HQ) of 0.1, 1, and 3 for the noncarcinogenic health effects and at various target risk levels (1E-06, 1E-05, 1E-04) for carcinogenic effects. The HH PRGs for the remaining coal ash and coal fines OUs (ash/soil) are provided in Table F-1.

F-5. ECOLOGICAL PRGS

The ecological risk assessment is presented in Appendix D of this document. No ecological RCOCs were identified for the remaining coal ash and coal fines OUs. Therefore, ecological PRGs are not developed in this appendix.

F-6. PRINCIPAL THREAT SOURCE MATERIAL PRGS

The principal threat source material (PTSM) evaluation is presented in Appendix E of this document. No PTSM RCOCs were identified for remaining coal ash and coal fines OUs. Therefore, no PTSM PRGs are presented in this appendix.

Table F-1. Human Health Risk-Based Preliminary Remediation Goals for the Remaining Coal Ash and Coal Fines OUs

RCOC	Units	Resident						Industrial Worker					
		Risk = 1E-06	Risk = 1E-05	Risk = 1E-04	HQ = 0.1	HQ = 1	HQ = 3	Risk = 1E-06	Risk = 1E-05	Risk = 1E-04	HQ = 0.1	HQ = 1	HQ = 3
Arsenic	mg/kg	6.77E-01	6.77E+00	6.77E+01	3.49E+00	3.49E+01	1.05E+02	3.00E+00	3.00E+01	3.00E+02	--	--	--
Potasium-40	pCi/g	1.44E-01	1.44E+00	1.44E+01	--	--	--	2.19E-01	2.19E+00	2.19E+01	--	--	--
Thorium-232	pCi/g	9.85E-03	9.85E-02	9.85E-01	--	--	--	1.53E-02	1.53E-01	1.53E+00	--	--	--
Uranium-238[1]	pCi/g	1.25E-02	1.25E-01	1.25E+00	--	--	--	2.00E-02	2.00E-01	2.00E+00	--	--	--

-- not applicable
HQ hazard quotient
RCOC refined constituent of concern
Note: Risk-based PRGs are based on the Regional Screening Levels (RSLs) (1E-06) from the U.S. Environmental Protection Agency (USEPA) RSLs website for nonradiological constituents and Preliminary Remediation Goals (PRGs) (1E-06) from the USEPA PRG website for radiological constituents that are provided in Appendix C.

1) Radium-226 was identified as a HH RCOC for the AAP; however, radium-226 is a daughter product of the uranium-238 decay series and will be managed under the cleanup level established for the entire decay series.

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APPENDIX G

Natural Resource Injury Evaluation

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NATURAL RESOURCE INJURY EVALUATION CHECKLIST

The purpose of the Natural Resource Injury Evaluation (NRIE) checklist is to identify potential natural resource injuries associated with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Resource Conservation and Recovery Act (RCRA) remedial activities. This 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.

If potential injuries are identified, consideration is given as to whether or not trustee involvement is needed. The checklist is a starting point in potential injury identification and is not intended to be all-inclusive. The checklist has been designed as a series of questions to help identify the potential for natural resource injuries and what resources may be affected. It is based on the pre-assessment screen in Title 43 *Code of Federal Regulations* Part 11.13.

The intent of the checklist is to prevent potential injuries to natural resources that can occur as the result of remediation activities and to mitigate, to the extent practical, any injuries that have already occurred. Trustees are consulted early in the scoping process so they can provide effective input for decisions regarding natural resources.

Five main areas are being 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?
- Would implementation of the alternative cause additional injuries?
- What potential irreversible and irretrievable resource losses may be identified?

The checklist may be re-visited and revised as CERCLA activities continue and additional information from the A-Area Ash Pile (AAP) (788-A), A-Area Coal Pile Runoff Basin (ACPRB) (788-3A), F-Area Ash Landfill (FAL) (288-F), H-Area Ash Basin (HAB) (288-H), K-Area Ash

Basin (KAB) (188-K), and the L-Area Ash Basin (LAB) (188-L) Operable Units (OUs) become available.

1. Has a release of a hazardous substance occurred?

Yes. OU-related constituents (arsenic, potassium-40, radium-226, Thorium-232, and uranium-238) were identified as refined constituents of concern based on a residential and/or industrial scenario for the surface soil medium.

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?

Yes. 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 Oil and Hazardous Substances Pollution Contingency Plan 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: 1) surface water resources, 2) groundwater resources, 3) air resources, 4) geologic resources, and 5) biological resources. Resources can also be classified as direct use (i.e., drinking water, hunting, etc.) or nonuse (i.e., 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 (e.g., nesting sites, threatened and endangered species, natural areas, etc.).

While refined contaminants of concern (RCOCs) are associated with soil media, there is no indication that constituents present in these media have migrated to surrounding soil or to underlying groundwater.

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

Localized soil.

3. Is the amount of hazardous substance released sufficient to potentially cause a natural resource injury?

Yes. The RCOCs previously identified in checklist item #1 will likely prevent unrestricted use of the land at the AAP, ACPRB, FAL, HAB, KAB, and LAB subunits.

4. Will the remedial alternatives being considered, or action already taken, sufficiently address the injuries to natural resources (including residual injuries)?

Remedial alternatives are identified and evaluated in the Corrective Measures Study/Feasibility Study (Section 5). Each alternative is evaluated as to whether it would be protective of human health and the environment.

5. Will the remedial alternatives being considered produce additional impacts to natural resources during remediation?

Remedial alternatives are identified and evaluated in the CMS/FS (Section 5). Each alternative is evaluated as to whether it would impact surrounding natural resources during and after implementation.

The potential costs for addressing resource injuries during remedial action implementation will be taken into consideration when selecting a remedial alternative. The liability (damage) 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.

No irreversible and/or irretrievable resource losses are known to exist associated with the remedial action options developed for the AAP, ACPRB, FAL, HAB, KAB, and LAB OUs.

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Table G-1. Savannah River Site Natural Resource Trustees and Their Responsibilities

U.S. Department of Energy, Savannah River Operations Office *All natural resources located on, over, or under land administrated by the USDOE*
South Carolina Office of the Governor *All natural resources of the state of South Carolina*
South Carolina Department of Environmental Services Bureau of Land and Waste Management *Geologic resources including soil* *Groundwater resources including drinking water sources* *Air resources* *Surface water resources*
U.S. Department of the Interior *Threatened and endangered species (includes the Red-Cockaded Woodpecker, Bald Eagle, Wood Stork, American Alligator, Shortnose Sturgeon, and Smooth Coneflower)* *Migratory birds* *Anadromous species* *National Park Service land - Fort Pulaski National Monument* *Fish and Wildlife Service land - Savannah River National Wildlife Refuge, Tybee Island National Wildlife Refuge, and Orangeburg National Fish Hatchery*
South Carolina Department of Natural Resources *Commercial species* *Game and nongame species* *State sensitive species*
Georgia Department of Natural Resources *Savannah River resources* *Groundwater resources* *Air resources* *Surface water resources*
U.S. Department of Commerce, National Oceanic and Atmospheric Administration *Living and nonliving natural resources in coastal and marine areas including:* – *All life stages, wherever they occur, of fishery resources on the Exclusive Economic Zone and continental shelf* – *Anadromous and catadromous species throughout their ranges* – *Rivers and tributaries to rivers which historically or presently support the above species* – *Federally endangered and threatened species, including designated critical habitat and marine mammals for which NOAA has assigned responsibility* – *Tidal wetlands, salt marshes, estuaries, and all other habitats supporting all fishery and marine resources listed above* – *Living and nonliving resources of National Marine Sanctuaries and National Estuarine Reserves*
U.S. Army Corps of Engineers, Charleston, South Carolina District Savannah, Georgia District *Savannah River resources* *Navigable waters resources* *Waters of the United States resources*

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APPENDIX H

COST ESTIMATES

Cost Estimates

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Abbreviations for Cost Estimates

Abbreviation	Definition
ac	acre
ea	each
ft	feet
gal	gallon
IWT	Industrial Wastewater Treatment
lf	linear feet
ls	lump sum
O&M	Operations and Maintenance
PP	Proposed Plan
ROD	Record of Decision
SER	Site Evaluation Report
yd^2	square yards
yd^3	cubic yard

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CCR/Ash Basin Strategy – CCR/Ash Waste Units Requiring Closure

CCR/Ash Unit	Notes	Inside Area	Total Area	Total Estimated Ash Volume	FFA RA START	Comments	In-Situ Options: In-Situ Cost Estimates	No Action	LUCs Only	Cap In-Place w/ SCDES Class III Cover system
		(acres)	(acres)	(cy)			Alternative	1	2	3
A-Area Ash Pile 788-A	Ash was trucked from the power plant and piled from 1950-1980 (approx.)	1.60	2.55	**70,000**	Mar-26	Proposed Plan (PP) to consolidate in CPRB	A-Ash	$0	$2,477,495	N/A
A-Area Coal Pile Runoff Basin, 788-3A	Coal fines present – no ash *Ref: PP	2.62	2.62	10,000	Mar-26	Inactive	A-CPRB	$0	$1,005,629	$8,155,203
F-Area Ash Landfill, 288-0F	Ash is currently being consolidated into an unlined basin.	7.01	18.48	**213,459**	Dec-24 (SER)	Currently "active". IWT closure 2023	F-Ash	$0	$13,831,805	$10,741,846
H-Area Ash Basin, 288-0H	Ash was sluiced into this basin from 1950-1990. Currently basin is heavily vegetated and a portion of it is within a wetland.	13.06	31.46	259,112	Dec 2034 (SER)	Potential Wetlands	H-Ash	$0	$9,033,599	$13,195,168
K-Area Ash Basin, 188-0K	Ash was sluiced into this basin from 1950-1990. Currently basin is heavily vegetated and does not have standing water.	11.16	14.97	**272,527**	Dec-28	Potential Consolidation location	K-Ash	$0	$5,931,458	$11,185,501
L-Area Ash Basin, 188-0L	Ash was sluiced into this basin from 1950-1968. Currently basin is heavily vegetated and does not have standing water.	17.61	19.28	323,026	Nov-29	Potential Consolidation location	L-Ash	$0	$7,327,969	$16,387,052
				(estimate)						
Ash Basins Grand Totals	A-, F-, H-, K-, and L-Ash Basins and A-CPRB	**50.4**	**86.7**	**1,138,124**	yd^3		**Totals**	**$0**	**$39,607,954**	**$59,664,770**
				1,365,749	20% fluff					

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No Action
Alternatives A-1
All Ash Basins

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
No Action				
Subtotal - Direct Capital Cost				$0
Mobilization/Demobilization	9%	of subtotal direct capital		$0
Site Preparation/Site Restoration	9%	of subtotal direct capital		$0
Total Direct Capital Cost				**$0**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$0
Project/Construction Management	25%	of direct capital		$0
Health & Safety	6%	of direct capital		$0
Overhead	30%	of direct capital + indirect capital		$0
Contingency	26%	of direct capital + indirect capital		$0
Total Indirect Capital Cost				**$0**
Total Estimated Capital Cost				**$0**
Direct O&M Costs	2.5%	30 Year Discount Rate1		
Annual Costs	30	years O&M		*Years 2029-2058*
Subtotal - 30 Year Annual Costs				**$0**
Present Value Cost				**$0**
Five Year Costs	0			
Remedy Review	0	ea	$15,000	$0
Subtotal - Five Year O&M Costs				$0
Present Value Cost				**$0**
Total Present Value Direct O&M Cost				**$0**
Indirect O&M Costs				
Project/Admin Management	146%	of direct O&M		$0
Health & Safety	19%	of direct O&M		$0
Overhead	30%	of direct O&M + indirect O&M		$0
Contingency	20%	of direct O&M + indirect O&M		$0
Total Present Worth Indirect O&M Cost				$0
Total Estimated Present Worth O&M Cost				**$0**
TOTAL ESTIMATED COST				**$0**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

Institutional Controls Estimate
Alternatives A-2
Land Use Controls w/Beneficial Reuse*

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
A-ASH				
Monitoring Wells				
Install monitoring wells to 120ft , core from surface to TD	0	ea	$20,324	$0
Technical Oversight	0	ls	$37,932	$0
Institutional Controls				
Install inclinometers	1	ea	$12,000	$12,000
Posting of Warning Signs	4	ea	$500	$2,000
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Off-Unit Disposal				
Excavate & Load Sediment / Coal Ash for Hauling	70,000	yd3	$3.59	$251,300
Confirmation Sampling / Analysis	15	ea	$1,000	$15,000
Stormwater Management	1,333	lf	$25	$33,325
Site Restoration				
Contour Basin After Sediment / Coal Removal	2.55	ac	$1,700	$4,335
Common Backfill (4 Inches)	1,645	yd3	$13	$21,385
Topsoil (4 Inches)	1,645	yd3	$35	$57,575
Fertilizer, Lime, Seed & Mulch	14,810	yd2	$0.75	$11,108
Backfill Sampling / Analysis	4	ea	$1,200	$4,800
Subtotal - Direct Capital Cost				$422,828
Mobilization/Demobilization	9%	of subtotal direct capital		$38,054
Site Preparation/Site Restoration	9%	of subtotal direct capital		$38,054
Total Direct Capital Cost				**$498,936**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$69,851
Project/Construction Management	25%	of direct capital		$124,734
Health & Safety	6%	of direct capital		$29,936
Overhead	30%	of direct capital + indirect capital		$217,037
Contingency	26%	of direct capital + indirect capital		$188,099
Total Indirect Capital Cost				**$629,658**
Total Estimated Capital Cost				**$1,128,594**
Direct O&M Costs	2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)	2	years O&M		*Years 2027-2028*
Access Controls	1	ea	$500	$500
Maintenance	1	ea	$3,442	$3,442
Subtotal - Annual Costs				$3,942
Present Value Cost				**$7,631**
	2.5%	30 Year Discount Rate1		
Annual Costs	30	years O&M		*Years 2029-2058*
Access Controls	1	ea	$500	$500
Annual Inspection/Maintenance	1	ea	$3,442	$3,442
Slope Stability Monitoring	1	ea	$12,000	$12,000
Subtotal - 30 Year Annual Costs				$15,942

	Present Value Cost			**$333,670**
Five Year Costs		6		
Remedy Review		1 ea	$15,000	$15,000
Groundwater Monitoring - 4 wells		0 ea	$7,000	$0
Subtotal - Five Year O&M Costs				$15,000
	Present Value Cost			**$87,602**
	Total Present Value Direct O&M Cost			**$428,903**
Indirect O&M Costs				
Project/Admin Management		146%	of direct O&M	$626,199
Health & Safety		19%	of direct O&M	$81,492
Overhead		30%	of direct O&M + indirect O&M	$128,671
Contingency		20%	of direct O&M + indirect O&M	$83,636
	Total Present Worth Indirect O&M Cost			$919,997
	Total Estimated Present Worth O&M Cost			**$1,348,900**
	TOTAL ESTIMATED COST			**$2,477,495**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

Institutional Controls Estimate
Alternatives AC-2
Land Use Controls w/Beneficial Reuse*

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
A-CPRB				
Monitoring Wells				
Drill/core rotosonic soil borings to 120 ft	0	ea	$20,324	$0
Technical Oversight	0	ls	$37,932	$0
Institutional Controls				
Posting of Warning Signs	4	ea	$500	$2,000
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Off-Unit Disposal				
Excavate & Load Sediment / Coal Ash for Hauling	10,000	yd3	$3.59	$35,900
Confirmation Sampling / Analysis	15	ea	$1,000	$15,000
Stormwater Management	1,351	lf	$25	$33,775
Site Restoration				
Contour Basin After Sediment / Coal Removal	2.62	ac	$1,700	$4,454
Common Backfill (4 Inches)	1,690	yd3	$13	$21,970
Topsoil (4 Inches)	1,690	yd3	$35	$59,150
Fertilizer, Lime, Seed & Mulch	15,216	yd2	$0.75	$11,412
Backfill Sampling / Analysis	4	ea	$1,200	$4,800
Subtotal - Direct Capital Cost				$198,461
Mobilization/Demobilization	9%	of subtotal direct capital		$17,861
Site Preparation/Site Restoration	9%	of subtotal direct capital		$17,861
Total Direct Capital Cost				**$234,184**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$32,786
Project/Construction Management	25%	of direct capital		$58,546
Health & Safety	6%	of direct capital		$14,051
Overhead	30%	of direct capital + indirect capital		$101,870
Contingency	26%	of direct capital + indirect capital		$88,287
Total Indirect Capital Cost				**$295,540**
Total Estimated Capital Cost				**$529,724**

Direct O&M Costs		2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)		2	years O&M		*Years 2027-2028*
Access Controls		1	ea	$500	$500
Maintenance		1	ea	$3,506	$3,506
	Subtotal - Annual Costs				$4,006
	Present Value Cost				**$7,754**
		2.5%	30 Year Discount Rate1		
Annual Costs		30	years O&M		*Years 2029-2058*
Access Controls		1	ea	$500	$500
Annual Inspection/Maintenance		1	ea	$3,506	$3,506
	Subtotal - 30 Year Annual Costs				$4,006
	Present Value Cost				**$83,838**
Five Year Costs		6			
Remedy Review		1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells		0	ea	$7,000	$0
Subtotal - Five Year O&M Costs					$15,000
	Present Value Cost				**$59,729**
	Total Present Value Direct O&M Cost				**$151,321**
Indirect O&M Costs					
Project/Admin Management		146%	of direct O&M		$220,929
Health & Safety		19%	of direct O&M		$28,751
Overhead		30%	of direct O&M + indirect O&M		$45,396
Contingency		20%	of direct O&M + indirect O&M		$29,508
	Total Present Worth Indirect O&M Cost				$324,584
	Total Estimated Present Worth O&M Cost				**$475,905**
	TOTAL ESTIMATED COST				**$1,005,629**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

Institutional Controls Estimate
Alternatives F-2
Land Use Controls w/Beneficial Reuse*

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
F-ASH				
Institutional Controls				
Posting of Warning Signs	11	ea	$500	$5,500
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Off-Unit Disposal				
Excavate & Load Sediment / Coal Ash for Hauling	205,703	yd3	$3.59	$766,318
Confirmation Sampling / Analysis	110	ea	$1,000	$110,000
Stormwater Management	3,588	lf	$25	$89,700
Site Restoration				
Contour After Sediment / Coal Removal	18.48	ac	$1,700	$31,416
Common Backfill (4 Inches)	11,925	yd3	$13	$155,025
Topsoil (4 Inches)	11,925	yd3	$35	$417,375
Fertilizer, Lime, Seed & Mulch	107,331	yd2	$0.75	$80,498
Backfill Sampling / Analysis	24	ea	$1,200	$28,800
Subtotal - Direct Capital Cost				$1,694,632
Mobilization/Demobilization	9%	of subtotal direct capital		$152,517
Site Preparation/Site Restoration	9%	of subtotal direct capital		$152,517
Total Direct Capital Cost				**$1,999,666**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$279,953
Project/Construction Management	25%	of direct capital		$499,916
Health & Safety	6%	of direct capital		$119,980
Overhead	30%	of direct capital + indirect capital		$869,855
Contingency	26%	of direct capital + indirect capital		$753,874
Total Indirect Capital Cost				**$2,523,578**
Total Estimated Capital Cost				**$4,523,244**

Direct O&M Costs	2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)	2	years O&M		*Years 2027-2028*
Access Controls	1	ea	$500	$500
Maintenance	12	ea	$9,361	$112,328
Groundwater Monitoring - 4 wells	2	ea	$7,000	$14,000
Subtotal - Annual Costs				$126,828
Present Value Cost				**$245,524**
	2.5%	30 Year Discount Rate1		
Annual Costs	30	years O&M		*Years 2029-2058*
Access Controls	1	ea	$500	$500
Monthly Inspections/Maintenance	12	ea	$9,361	$112,328
Groundwater Monitoring - 4 wells	2	ea	$7,000	$14,000
Subtotal - 30 Year Annual Costs				$126,828
Present Value Cost				**$2,654,544**
Five Year Costs	6			
Remedy Review	1	ea	$15,000	$15,000
Subtotal - Five Year O&M Costs				$15,000
Present Value Cost				**$59,729**
Total Present Value Direct O&M Cost				**$2,959,797**
Indirect O&M Costs				
Project/Admin Management	146%	of direct O&M		$4,321,303
Health & Safety	19%	of direct O&M		$562,361
Overhead	30%	of direct O&M + indirect O&M		$887,939
Contingency	20%	of direct O&M + indirect O&M		$577,160
Total Present Worth Indirect O&M Cost				$6,348,764
Total Estimated Present Worth O&M Cost				**$9,308,560**
TOTAL ESTIMATED COST				**$13,831,805**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*

Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

Institutional Controls Estimate
Alternatives H-2
Land Use Controls w/Beneficial Reuse*

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
H-ASH				
Monitoring Wells				
Drill/core rotosonic soil borings to 50 ft	4	ea	$17,277	$69,110
Technical Oversight	1	ea	$33,532	$33,532
Institutional Controls				
Posting of Warning Signs	15	ea	$500	$7,500
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Off-Unit Disposal				
Excavate & Load Sediment / Coal Ash for Hauling	259,112	yd3	$3.59	$930,212
Confirmation Sampling / Analysis	188	ea	$1,000	$188,000
Stormwater Management	4,682	lf	$25	$117,050
Site Restoration				
Contour Basin After Sediment / Coal Removal	31.46	ac	$1,700	$53,482
Common Backfill (4 Inches)	20,302	yd3	$13	$263,926
Topsoil (4 Inches)	20,302	yd3	$35	$710,570
Fertilizer, Lime, Seed & Mulch	182,719	yd2	$0.75	$137,039
Backfill Sampling / Analysis	41	ea	$1,200	$49,200
Subtotal - Direct Capital Cost				$2,466,979
Mobilization/Demobilization	9%	of subtotal direct capital		$222,028
Site Preparation/Site Restoration	9%	of subtotal direct capital		$222,028
Total Direct Capital Cost				**$2,911,036**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$407,545
Project/Construction Management	25%	of direct capital		$727,759
Health & Safety	6%	of direct capital		$174,662
Overhead	30%	of direct capital + indirect capital		$1,266,300
Contingency	26%	of direct capital + indirect capital		$1,097,460
Total Indirect Capital Cost				**$3,673,727**
Total Estimated Capital Cost				**$6,584,763**

Direct O&M Costs		2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)		2	years O&M		*Years 2027-2028*
Access Controls		1	ea	$500	$500
Maintenance		1	ea	$12,941	$29,721
	Subtotal - Annual Costs				$30,221
	Present Value Cost				**$58,505**
		2.5%	30 Year Discount Rate1		
Annual Costs		30	years O&M		*Years 2029-2058*
Access Controls		1	ea	$500	$500
Annual Inspection/Maintenance		1	ea	$12,941	$29,721
	Subtotal - 30 Year Annual Costs				$30,221
	Present Value Cost				**$632,537**
Five Year Costs		6			
Remedy Review		1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells		1	ea	$7,000	$7,000
Subtotal - Five Year O&M Costs					$15,000
	Present Value Cost				**$87,602**
	Total Present Value Direct O&M Cost				**$778,644**
Indirect O&M Costs					
Project/Admin Management		146%	of direct O&M		$1,136,821
Health & Safety		19%	of direct O&M		$147,942
Overhead		30%	of direct O&M + indirect O&M		$233,593
Contingency		20%	of direct O&M + indirect O&M		$151,836
	Total Present Worth Indirect O&M Cost				$1,670,192
	Total Estimated Present Worth O&M Cost				**$2,448,836**
	TOTAL ESTIMATED COST				**$9,033,599**

[1] Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

Institutional Controls Estimate
Alternatives K-2
Land Use Controls w/Beneficial Reuse*

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
K-ASH				
Monitoring Wells				
Drill/core rotosonic soil borings to 50 ft	0	ea	$17,277	$0
Technical Oversight	0	ea	$33,532	$0
Institutional Controls				
Posting of Warning Signs	10	ea	$500	$5,000
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Off-Unit Disposal				
Excavate & Load Sediment / Coal Ash for Hauling	272,527	yd3	$3.59	$978,372
Confirmation Sampling / Analysis	89	ea	$1,000	$89,000
Stormwater Management	3,230	lf	$25	$80,750
Site Restoration				
Contour Basin After Sediment / Coal Removal	14.97	ac	$1,700	$25,449
Common Backfill (4 Inches)	9,660	yd3	$13	$125,580
Topsoil (4 Inches)	9,660	yd3	$35	$338,100
Fertilizer, Lime, Seed & Mulch	86,945	yd2	$0.75	$65,209
Backfill Sampling / Analysis	20	ea	$1,200	$24,000
Subtotal - Direct Capital Cost				$1,741,460
Mobilization/Demobilization	9%	of subtotal direct capital		$156,731
Site Preparation/Site Restoration	9%	of subtotal direct capital		$1156,731
Total Direct Capital Cost				**$2,054,922**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$287,689
Project/Construction Management	25%	of direct capital		$513,731
Health & Safety	6%	of direct capital		$123,295
Overhead	30%	of direct capital + indirect capital		$893,891
Contingency	26%	of direct capital + indirect capital		$774,706
Total Indirect Capital Cost				**$2,593,312**
Total Estimated Capital Cost				**$4,648,235**

Direct O&M Costs		2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)		2	years O&M		*Years 2027-2028*
Access Controls		1	ea	$500	$500
Maintenance		1	ea	$14,732	$14,732
	Subtotal - Annual Costs				$15,232
	Present Value Cost				**$22,782**
		2.5%	30 Year Discount Rate1		
Annual Costs		30	years O&M		*Years 2029-2058*
Access Controls		1	ea	$500	$500
Annual Inspection/Maintenance		1	ea	$14,732	$14,732
	Subtotal - 30 Year Annual Costs				$15,232
	Present Value Cost				**$318,805**
Five Year Costs		6			
Remedy Review		1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells		0	ea	$7,000	$0
Subtotal - Five Year O&M Costs					$15,000
	Present Value Cost				**$59,729**
	Total Present Value Direct O&M Cost				**$408,020**
Indirect O&M Costs					
Project/Admin Management		146%	of direct O&M		$595,710
Health & Safety		19%	of direct O&M		$77,524
Overhead		30%	of direct O&M + indirect O&M		$122,406
Contingency		20%	of direct O&M + indirect O&M		$79,564
	Total Present Worth Indirect O&M Cost				$875,203
	Total Estimated Present Worth O&M Cost				**$1,283,224**
	TOTAL ESTIMATED COST				**$5,931,458**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

Institutional Controls Estimate
Alternatives L-2
Land Use Controls w/Beneficial Reuse*

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
L-ASH				
Monitoring Wells				
Drill/core rotosonic soil borings to 50 ft	4	ea	$17,277	$69,110
Technical Oversight	1	ea	$33,532	$33,532
Institutional Controls				
Posting of Warning Signs	12	ea	$500	$6,000
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Off-Unit Disposal				
Excavate & Load Sediment / Coal Ash for Hauling	323,026	yd3	$3.59	$1,159,663
Confirmation Sampling / Analysis	115	ea	$1,000	$115,000
Stormwater Management	3,665	lf	$25	$91,625
Site Restoration				
Contour Basin After Sediment / Coal Removal	19.28	ac	$1,700	$32,776
Common Backfill (4 Inches)	12,442	yd3	$13	$161,746
Topsoil (4 Inches)	12,442	yd3	$35	$435,470
Fertilizer, Lime, Seed & Mulch	111,978	yd2	$0.75	$83,984
Backfill Sampling / Analysis	25	ea	$1,200	$30,000
Subtotal - Direct Capital Cost				$2,126,264
Mobilization/Demobilization	9%	of subtotal direct capital		$191,364
Site Preparation/Site Restoration	9%	of subtotal direct capital		$191,364
Total Direct Capital Cost				**$2,508,991**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$351,259
Project/Construction Management	25%	of direct capital		$627,248
Health & Safety	6%	of direct capital		$150,539
Overhead	30%	of direct capital + indirect capital		$1,091,411
Contingency	26%	of direct capital + indirect capital		$945,890
Total Indirect Capital Cost				**$3,166,347**
Total Estimated Capital Cost				**$5,675,338**

Direct O&M Costs		2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)		2	years O&M		*Years 2027-2028*
Access Controls		1	ea	$500	$500
Maintenance		1	ea	$18,650	$18,650
	Subtotal - Annual Costs				$19,150
	Present Value Cost				**$37,071**
		2.5%	30 Year Discount Rate1		
Annual Costs		30	years O&M		*Years 2029-2058*
Access Controls		1	ea	$500	$500
Annual Inspection/Maintenance		1	ea	$18,650	$18,650
	Subtotal - 30 Year Annual Costs				$19,150
	Present Value Cost				**$400,805**
Five Year Costs		6			
Remedy Review		1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells		1	ea	$7,000	$7,000
Subtotal - Five Year O&M Costs					$15,000
	Present Value Cost				**$87,602**
	Total Present Value Direct O&M Cost				**$525,479**
Indirect O&M Costs					
Project/Admin Management		146%	of direct O&M		$767,199
Health & Safety		19%	of direct O&M		$99,841
Overhead		30%	of direct O&M + indirect O&M		$157,644
Contingency		20%	of direct O&M + indirect O&M		$102,468
	Total Present Worth Indirect O&M Cost				$1,127,152
	Total Estimated Present Worth O&M Cost				**$1,652,630**
	TOTAL ESTIMATED COST				**$7,327,969**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

A-Ash Pile (AAP) Estimate
Alternative A-3
Consolidate AAP at ACPRB, Soil Cover, Land Use Controls

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
A-Ash				
Clear and Grubbing				
Clear Vegetation and Debris, Stockpile at Site Perimeter	3.0	ac	$2,600	$7,800
Clear Trees and Grub Stumps, Stockpile at Site Perimeter	3.0	ac	$4,500	$13,500
Access Road	1,320	lf	$12	$15,840
Excavate, Truck Haul and Dump Soil For Disposal at ACPRB				
Excavate & Load Ash for Hauling	70,000	yd^3	3.59	$251,300
Truck Haul Contaminated Soil to Disposal Site	84,000	yd^3	4.6	$386,400
Backfill / Compact Soil at ACPRB	84,000	yd^3	2.5	$210,000
Site Restoration where Ash Removed				
Confirmation Sampling / Analysis	15	ea	$1,000	$15,000
Contour Basin After Sediment / Ash Removal	2.55	ac	$1,700.00	$2,550
Common Backfill (4 Inches)	968	yd^3	$13.00	$12,584
Topsoil (4 Inches)	968	yd^3	$35.00	$33,880
Fertilizer, Lime, Seed & Mulch	8,712	yd^2	$0.75	$6,534
Backfill Sampling / Analysis	2	ea	$1,200.00	$4,800
Stormwater Management	1,333	lf	$25	$33,325
A-CPRB				
Clearing and Grubbing				
Clear Trees and Grub Stumps, Stockpile at Site Perimeter	3.1	ac	$4,500	$13,950
Contour Site After Clearing and Grubbing	3.1	ac	$1,700	$5,270
Monitoring Wells				
Drill/core rotosonic soil borings to 120 ft	4	ea	$40,647	$162,589
Technical Oversight	1	ea	$37,932	$37,932
A Area Coal Pile Runoff Basin Content Treatment				
A Area CPRB Access Road	2,640	lf	$12	$31,680
Surface Water Initial Testing - Allowance	1	ls	$5,000	$5,000
Ph Adjustment - Allowance	1	ls	$15,000	$15,000
Surface Water Ph Adjustment Testing - Allowance	1	ls	$5,000	$5,000
Flocculate Metals For Water Discharging - Allowance	1	ls	$15,000	$15,000
Surface Water Flocculate Testing - Allowance	1	ls	$5,000	$5,000
Dewater A Area Coal Pile Runoff Basin / Discharge to Ground	1,400,000	gal	$0.005	$7,000
Construct SCDHEC Class III Cover system				
Design	1	ea	$300,000	$300,000
Site Layout and Surveys w/ As-Builts	3.4	ac	$3,000	$10,200
Fill and Grade for Slope (12 inches average)	5,072.0	yd^3	$13	$65,936
Structural Backfill (6 inches) and Grade for Slope	2,536	yd^3	$13	$32,968
Geosynthetic Liner (GCL, GDL, riprap drainage)	12,680	yd^2	$31	$393,080
Common Backfill (20 Inches)	8,453	yd^3	$13	$109,889
Topsoil (4 Inches)	1,690	yd^3	$35	$59,150
Sod	15,216	yd^2	$5	$76,080
Stockpile Fill Soil	12,680	yd^3	$16	$202,880

Backfill Sampling / Analysis	11	ea	$1,200	$13,200
Stormwater Management	1,351	lf	$25	$33,775
Institutional Controls				
Posting of Warning Signs	4	ea	$500	$2,000
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Subtotal - Direct Capital Cost				$2,606,092
Mobilization/Demobilization	9%	of subtotal direct capital		$234,548
Site Preparation/Site Restoration	9%	of subtotal direct capital		$234,548
Total Direct Capital Cost				**$3,075,189**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$430,526
Project/Construction Management	25%	of direct capital		$768,797
Health & Safety	6%	of direct capital		$184,511
Overhead	30%	of direct capital + indirect		$1,337,707
Contingency	26%	of direct capital + indirect		$1,159,346
Total Indirect Capital Cost				**$3,880,888**
Total Estimated Capital Cost				**$6,956,077**

Direct O&M Costs		2.2%	3 Year Discount Rate1 [1]		
Annual Costs (Existing System during Post-ROD Design & Const)		2	years O&M	*Years*	*2027-2028*
Access Controls		1	ea	$500	$500
Maintenance		1	ea	$8,925	$8,925
	Subtotal -Annual Costs				$9,425
	Present Worth Annual Costs				$18,246
		2.5%	30 Year Discount Rate [1]		
Annual Costs (Institutional Controls)		30	years O&M	*Years*	*2029-2058*
Access Controls		1	ea	$500	$500
Annual Inspections / Maintenance		1	ea	$8,925	$8,925
	Subtotal - Annual Costs				$9,425
	Present Worth Annual Costs				$190,924
Five Year Costs		6			
Remedy Review		1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells		1	ea	$7,000	$7,000
	Subtotal - Five Year O&M Costs				$22,000
	Present Worth Five-Year Costs				$93,506
	Total Present Worth Direct O&M Cost				**$302,676**
Indirect O&M Costs					
Project/Admin Management		146%	of direct O&M		$441,906
Health & Safety		19%	of direct O&M		$57,508
Overhead		30%	of direct O&M + indirect		$240,627
Contingency		20%	of direct O&M + indirect		$156,408
	Total Present Worth Indirect O&M Cost				$896,450
	Total Estimated Present Worth O&M Cost				$1,199,125
	TOTAL ESTIMATED COST				**$8,155,203**

Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

F-Ash Landfill Estimate
Alternative F-3
SCDHEC Class III Cover system

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
F-Ash				
Clearing and Grubbing				
Clear Vegetation and Debris, Stockpile at Site Perimeter	24.5	ac	$2,600	$63,700
Clear Trees and Grub Stumps, Stockpile at Site Perimeter	24.5	ac	$4,500	$110,250
Access Road	2,640	lf	$12	$31,680
Close In-Situ Item Basin w/ SCDHEC Class III Cover system				
Construct SCDHEC Class III Cover system				
Design	1	ea	$300,000	$300,000
Site Layout and Surveys w/ As-Builts	9.3	ac	$3,000	$27,900
Structural Backfill (6 inches) and Grade for Slope	6,785	yd^3	$13	$88,205
Geosynthetic Liner (GCL, GDL, riprap drainage)	33,928	yd^2	$31	$1,051,768
Common Backfill (20 Inches)	22,618	yd^3	$13	$294,034
Topsoil (4 Inches)	4,523	yd^3	$35	$158,305
Sod	40,714	yd^2	$5	$203,570
Site Restoration				
Contour Basin After Sediment / Coal Removal	20.3	ac	$1,700	$34,510
Common Backfill (4 Inches)	11,925	yd^3	$13	$155,025
Topsoil (4 Inches)	11,925	yd^3	$35	$417,375
Fertilizer, Lime, Seed & Mulch	53,665	yd^2	$0.75	$40,249
Backfill Sampling / Analysis	24	ea	$1,200	$28,800
Stormwater Management	3,588	lf	$25	$89,700
Institutional Controls				
Posting of Warning Signs	7	ea	$500	$3,500
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Subtotal - Direct Capital Cost				$3,108,571
Mobilization/Demobilization	9%	of subtotal direct capital		$279,771
Site Preparation/Site Restoration	9%	of subtotal direct capital		$279,771
Total Direct Capital Cost				**$3,668,113**
Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$513,536
Project/Construction Management	25%	of direct capital		$917,028
Health & Safety	6%	of direct capital		$220,087
Overhead	30%	of direct capital + indri		$1,596,629
Contingency	26%	of direct capital + indri		$1,383,879
Total Indirect Capital Cost				**$4,629,159**
Total Estimated Capital Cost				**$8,297,273**

Direct O&M Costs		2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)		2	years O&M		*Years 2027-2028*
Access Controls		1	ea	$500	$500
Maintenance		1	ea	$19,148	$19,148
	Subtotal - Annual Costs				$19,648
	Present Value Cost				**$38,036**
		2.5%	30 Year Discount Rate1		
Annual Costs		30	years O&M		*Years 2029-2058*
Access Controls		1	ea	$500	$500
Annual Inspection/Maintenance		1	ea	$19,148	$19,148
Groundwater Monitoring - 4 wells		2	ea	$7,000	$14,000
	Subtotal - 30 Year Annual Costs				$19,648
	Present Value Cost				**$411,238**
Five Year Costs		6			
Remedy Review		1	ea	$15,000	$15,000
Subtotal - Five Year O&M Costs					$15,000
	Present Value Cost				**$59,729**
	Total Present Value Direct O&M Cost				**$509,003**
Indirect O&M Costs					
Project/Admin Management		146%	of direct O&M		$1,170,960
Health & Safety		19%	of direct O&M		$152,385
Overhead		30%	of direct O&M + indirect		$369,874
Contingency		20%	of direct O&M + indirect		$240,418
	Total Present Worth Indirect O&M Cost				**$1,933,638**
	Total Estimated Present Worth O&M Cost				**$2,442,641**
	TOTAL ESTIMATED COST				**$10,741,846**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
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H-Ash Basin Estimate
Alternative H-3
SCDHEC Class III Cover system

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
H-Ash				
Clearing and Grubbing				
Clear Vegetation and Debris, Stockpile at Site Perimeter	41.8	ac	$2,600	$108,680
Clear Trees and Grub Stumps, Stockpile at Site Perimeter	41.8	ac	$4,500	$188,100
Access Road	2,640	lf	$12	$31,680
Monitoring Wells				
Drill/core rotosonic soil borings to 50 ft	4	ea	$17,277	$69,110
Technical Oversight	1	ea	$33,532	$33,532
Close In-Situ Item Basin w/ SCDHEC Class III Cover system				
Basin Content Treatment				
Surface Water Initial Testing - Allowance	1	ls	$5,000	$5,000
pH Adjustment - Allowance	1	ls	$15,000	$15,000
Surface Water pH Adjustment Testing - Allowance	1	ls	$5,000	$5,000
Flocculate Metals For Water Discharging - Allowance	1	ls	$15,000	$15,000
Surface Water Flocculate Testing - Allowance	1	ls	$5,000	$5,000
Dewater Basin / Discharge to Ground	1,400,000	gal	$0.005	$7,000
Dry Ash	259,000	yd3	$2	$518,224
Consolidate Ash within Basin	129,500	yd^3	$3.59	$465,106
Construct SCDHEC Class III Cover system				
Design	1	ea	$300,000	$300,000
Site Layout and Surveys w/ As-Builts	8.7	ac	$3,000	$25,950
Structural Backfill (6 inches) and Grade for Slope	6,321	yd^3	$13	$82,173
Geosynthetic Liner (GCL, GDL, riprap drainage)	31,605	yd^2	$31	$979,755
Common Backfill (20 Inches)	21,070	yd^3	$13	$273,910
Topsoil (4 Inches)	4,214	yd^3	$35	$147,490
Sod	37,926	yd^2	$5	$189,630
Site Restoration				
Contour Basin After Sediment / Coal Removal	15.7	ac	$1,700	$26,690
Common Backfill (4 Inches)	10,151	yd^3	$13	$131,963
Topsoil (4 Inches)	10,151	yd^3	$35	$355,285
Fertilizer, Lime, Seed & Mulch	45,680	yd^2	$0.75	$34,260
Backfill Sampling / Analysis	21	ea	$1,200	$25,200
Stormwater Management	4,682	lf	$25	$117,050
Institutional Controls				
Posting of Warning Signs	10	ea	$500	$5,000
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Subtotal - Direct Capital Cost				$4,170,788
Mobilization/Demobilization	9%	of subtotal direct capital		$375,371
Site Preparation/Site Restoration	9%	of subtotal direct capital		$375,371
Total Direct Capital Cost				**$4,921,530**

Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$689,014
Project/Construction Management	25%	of direct capital		$1,230,382
Health & Safety	6%	of direct capital		$295,292
Overhead	30%	of direct capital + indir		$2,140,865
Contingency	26%	of direct capital + indir		$1,855,417
Total Indirect Capital Cost				$6,210,970
Total Estimated Capital Cost				$11,132,500

Direct O&M Costs	2.2%	3 Year Discount Rate1		
Annual Costs (Existing System during Post-ROD Design & Const)	2	years O&M		*Years 2027-2028*
Access Controls	1	ea	$500	$500
Maintenance	1	ea	$33,292	$33,292
Subtotal - Annual Costs				$33,792
Present Value Cost				**$65,417**
	2.5%	30 Year Discount Rate1		
Annual Costs	30	years O&M		*Years 2029-2058*
Access Controls	1	ea	$500	$500
Annual Inspection/Maintenance	1	ea	$33,292	$33,292
Subtotal - 30 Year Annual Costs				$33,792
Present Value Cost				**$707,277**
Five Year Costs	6			
Remedy Review	1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells	1	ea	$7,000	$7,000
Subtotal - Five Year O&M Costs				$15,000
Present Value Cost				**$87,602**
Total Present Value Direct O&M Cost				**$860,297**
Indirect O&M Costs				
Project/Admin Management	146%	of direct O&M		$568,714
Health & Safety	19%	of direct O&M		$74,011
Overhead	30%	of direct O&M + indirect		$339,180
Contingency	20%	of direct O&M + indirect		$220,467
Total Present Worth Indirect O&M Cost				**$1,202,371**
Total Estimated Present Worth O&M Cost				**$2,062,668**
TOTAL ESTIMATED COST				**$13,195,168**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
Real Interest Rates for OMB Circular No. A-94 (12/28/23)
Treasury Notes and Bonds of Specified Maturities

K-Ash Basin Estimate
Alternative K-3
SCDHEC Class III Cover system

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
K-Ash				
Clearing and Grubbing				
Clear Vegetation and Debris, Stockpile at Site Perimeter	19.9	ac	$2,600	$51,740
Clear Trees and Grub Stumps, Stockpile at Site Perimeter	19.9	ac	$4,500	$89,550
Access Road	2,640	lf	$12	$31,680
Monitoring Wells				
Drill/core rotosonic soil borings to 50 ft	4	ea	$17,277	$69,110
Technical Oversight	1	ea	$33,532	$33,532
Close In-Situ Item Basin w/ SCDHEC Class III Cover system				
Basin Content Treatment				
Surface Water Initial Testing - Allowance	1	ls	$5,000	$5,000
pH Adjustment - Allowance	1	ls	$15,000	$15,000
Surface Water pH Adjustment Testing - Allowance	1	ls	$5,000	$5,000
Flocculate Metals For Water Discharging - Allowance	1	ls	$15,000	$15,000
Surface Water Flocculate Testing - Allowance	1	ls	$5,000	$5,000
Dewater Basin / Discharge to Ground	1,400,000	gal	$0.005	$7,000
Dry Ash	272,527	yd3	$2	$545,054
Consolidate Ash within Basin	136,264	yd^3	$3.59	$489,186
Construct SCDHEC Class III Cover system				
Design	1	ea	$300,000	$300,000
Site Layout and Surveys w/ As-Builts	7.4	ac	$3,000	$22,200
Structural Backfill (6 inches) and Grade for Slope	7,245	yd^3	$13	$94,185
Geosynthetic Liner (GCL, GDL, riprap drainage)	27,007	yd^2	$31	$837,217
Common Backfill (20 Inches)	18,005	yd^3	$13	$234,059
Topsoil (4 Inches)	3,601	yd^3	$35	$126,018
Sod	32,409	yd^2	$5	$162,043
Site Restoration				
Contour Basin After Sediment / Coal Removal	7.5	ac	$1,700	$12,665
Common Backfill (4 Inches)	4,830	yd^3	$13	$62,790
Topsoil (4 Inches)	4,830	yd^3	$35	$169,050
Fertilizer, Lime, Seed & Mulch	21,736	yd^2	$0.75	$16,302
Backfill Sampling / Analysis	10	ea	$1,200	$12,000
Stormwater Management	3,230	lf	$25	$80,750
Institutional Controls				
Posting of Warning Signs	9	ea	$500	$4,500
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Subtotal - Direct Capital Cost				$3,505,630
Mobilization/Demobilization	9%	of subtotal direct capital		$315,507
Site Preparation/Site Restoration	9%	of subtotal direct capital		$315,507
Total Direct Capital Cost				**$4,136,643**

Indirect Capital Costs					
Engineering & Design	14%	of direct capital			$579,130
Project/Construction Management	25%	of direct capital			$1,034,161
Health & Safety	6%	of direct capital			$248,199
Overhead	30%	of direct capital + indir			$1,799,440
Contingency	26%	of direct capital + indir			$1,559,514
Total Indirect Capital Cost					**$5,220,443**
Total Estimated Capital Cost					**$9,357,086**
Direct O&M Costs	2.2%	3 Year Discount Rate1			
Annual Costs (Existing System during Post-ROD Design & Const)	2	years O&M			*Years 2027-2028*
Access Controls	1	ea	$500		$500
Maintenance	1	ea	$28,857		$28,857
Subtotal - Annual Costs					$29,357
Present Value Cost					**$56,833**
	2.5%	30 Year Discount Rate1			
Annual Costs	30	years O&M			*Years 2029-2058*
Access Controls	1	ea	$500		$500
Annual Inspection/Maintenance	1	ea	$28,857		$28,857
Subtotal - 30 Year Annual Costs					$29,357
Present Value Cost					**$614,460**
Five Year Costs	6				
Remedy Review	1	ea	$15,000		$15,000
Groundwater Monitoring - 4 wells	1	ea	$7,000		$7,000
Subtotal - Five Year O&M Costs					$15,000
Present Value Cost					**$87,602**
Total Present Value Direct O&M Cost					**$758,895**
Indirect O&M Costs					
Project/Admin Management	146%	of direct O&M			$511,055
Health & Safety	19%	of direct O&M			$66,507
Overhead	30%	of direct O&M + indirect			$298,156
Contingency	20%	of direct O&M + indirect			$193,802
Total Present Worth Indirect O&M Cost					**$1,069,520**
Total Estimated Present Worth O&M Cost					**$1,828,415**
TOTAL ESTIMATED COST					**$11,185,501**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
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L-Ash Basin Estimate
Alternative L-3
SCDHEC Class III Cover system

Item	Quantity	Units	Unit Cost	Total Cost
Direct Capital Costs				
L-Ash				
Clearing and Grubbing				
Clear Vegetation and Debris, Stockpile at Site Perimeter	25.6	ac	$2,600	$66,560
Clear Trees and Grub Stumps, Stockpile at Site Perimeter	25.6	ac	$4,500	$115,200
Access Road	2,640	lf	$12	$31,680
Monitoring Wells				
Drill/core rotosonic soil borings to 50 ft	4	ea	$17,277	$69,110
Technical Oversight	1	ea	$33,532	$33,532
Close In-Situ Item Basin w/ SCDHEC Class III Cover system				
Basin Content Treatment				
Surface Water Initial Testing - Allowance	1	ls	$5,000	$5,000
pH Adjustment - Allowance	1	ls	$15,000	$15,000
Surface Water pH Adjustment Testing - Allowance	1	ls	$5,000	$5,000
Flocculate Metals For Water Discharging - Allowance	1	ls	$15,000	$15,000
Surface Water Flocculate Testing - Allowance	1	ls	$5,000	$5,000
Dewater Basin / Discharge to Ground	1,400,000	gal	$0.005	$7,000
Dry Ash	323,026	yd3	$2	$646,052
Consolidate Ash within Basin	161,513	yd3	$3.59	$579,832
Construct SCDHEC Class III Cover system				
Design	1	ea	$300,000	$300,000
Site Layout and Surveys w/ As-Builts	11.7	ac	$3,000	$35,100
Structural Backfill (6 inches) and Grade for Slope	9,332	yd3	$13	$121,310
Geosynthetic Liner (GCL, GDL, riprap drainage)	42,616	yd2	$31	$1,321,096
Common Backfill (20 Inches)	28,411	yd3	$13	$369,337
Topsoil (4 Inches)	5,682	yd3	$35	$198,870
Sod	51,139	yd2	$5	$255,695
Site Restoration				
Contour Basin After Sediment / Coal Removal	9.6	ac	$1,700	$16,320
Common Backfill (4 Inches)	6,221	yd3	$13	$80,873
Topsoil (4 Inches)	6,221	yd3	$35	$217,735
Fertilizer, Lime, Seed & Mulch	27,995	yd2	$0.75	$20,996
Backfill Sampling / Analysis	13	ea	$1,200	$15,600
Stormwater Management	3,665	lf	$25	$91,625
Institutional Controls				
Posting of Warning Signs	11	ea	$500	$5,500
Land Use Control Implementation Plan	1	ea	$5,000	$5,000
Deed Restrictions	1	ea	$5,000	$5,000
Subtotal - Direct Capital Cost				$4,654,022
Mobilization/Demobilization	9%	of subtotal direct capital		$418,862
Site Preparation/Site Restoration	9%	of subtotal direct capital		$418,862
Total Direct Capital Cost				**$5,491,746**

Indirect Capital Costs				
Engineering & Design	14%	of direct capital		$768,844
Project/Construction Management	25%	of direct capital		$1,372,936
Health & Safety	6%	of direct capital		$329,505
Overhead	30%	of direct capital + indirect		$2,388,909
Contingency	26%	of direct capital + indirect		$2,070,388
Total Indirect Capital Cost				$6,930,583
Total Estimated Capital Cost				$12,422,329
Direct O&M Costs	2.2%	3 Year Discount Rate[1]		
Annual Costs (Existing System during Post-ROD Design & Const)	2	years O&M		*Years 2027-2028*
Access Controls	1	ea	$500	$500
Maintenance	1	ea	$43,912	$43,912
Subtotal - Annual Costs				$44,412
Present Value Cost				**$85,976**
	2.5%	30 Year Discount Rate[1]		
Annual Costs	30	years O&M		*Years 2029-2058*
Access Controls	1	ea	$500	$500
Annual Inspection/Maintenance	1	ea	$43,912	$43,912
Subtotal - 30 Year Annual Costs				$44,412
Present Value Cost				**$929,551**
Five Year Costs	6			
Remedy Review	1	ea	$15,000	$15,000
Groundwater Monitoring - 4 wells	1	ea	$7,000	$7,000
Subtotal - Five Year O&M Costs				$15,000
Present Value Cost				**$87,602**
Total Present Value Direct O&M Cost				**$1,103,129**
Indirect O&M Costs				
Project/Admin Management	146%	of direct O&M		$1,619,601
Health & Safety	19%	of direct O&M		$210,770
Overhead	30%	of direct O&M + indirect		$624,984
Contingency	20%	of direct O&M + indirect		$406,239
Total Present Worth Indirect O&M Cost				**$2,861,594**
Total Estimated Present Worth O&M Cost				**$3,964,723**
TOTAL ESTIMATED COST				**$16,387,052**

[1] *Interest rates for costs with 3-year and 30-year durations are based on SRNS Technical Memorandum ERTEC-2017-00002.*
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