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

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SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

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

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

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.

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 ~~threatened, endangered, and sensitive (~~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

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)

(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

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 FCMS/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 (~) 0.65 ha (1.60 ac). The ash within the AAP extends northward towards the edge of an unnamed tributary to Tims Branch

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

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

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.

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 are 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 2023b). 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.

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 yd^3] 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

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

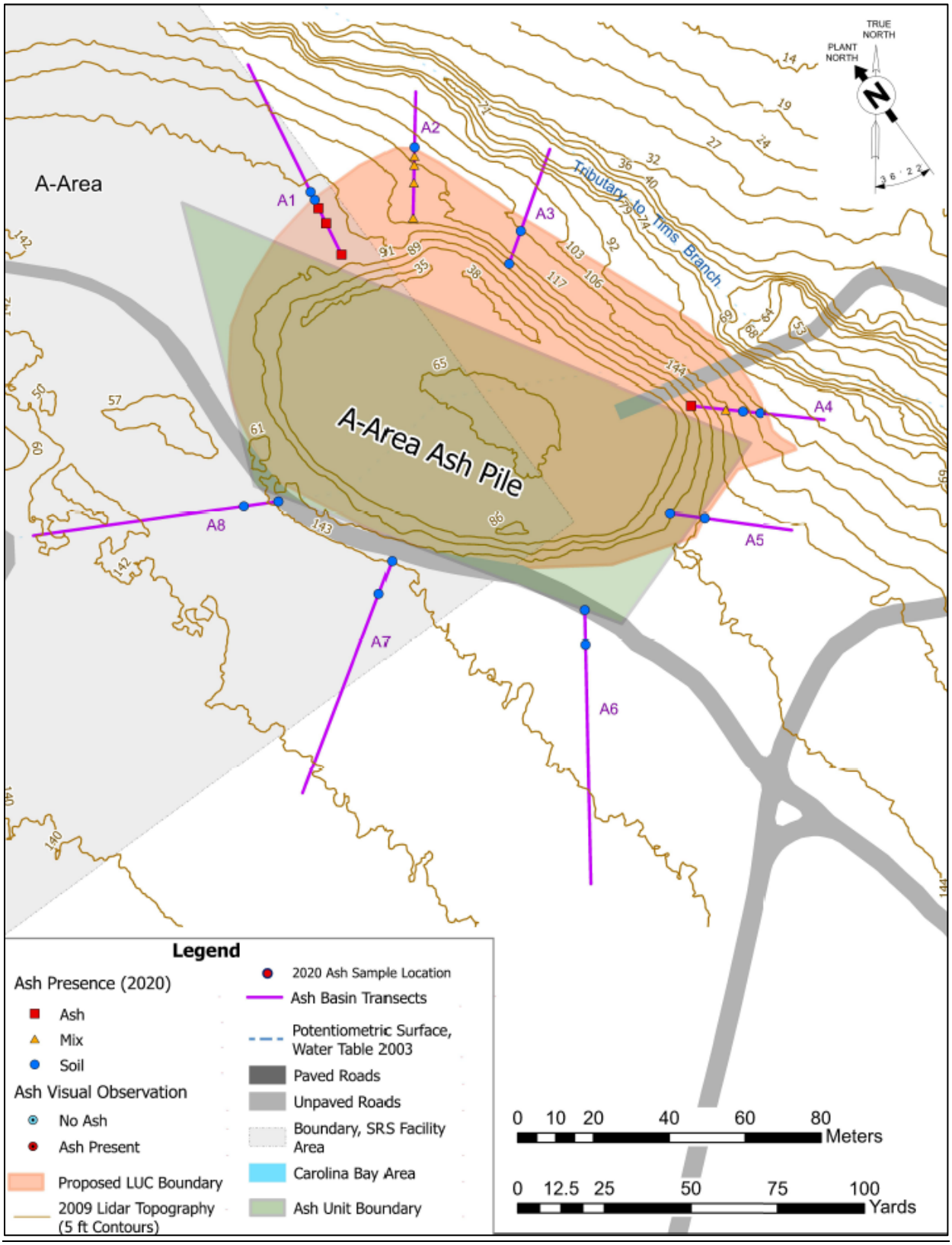

Figure 3. A-Area Ash Pile Topography and Ash Observation Transects

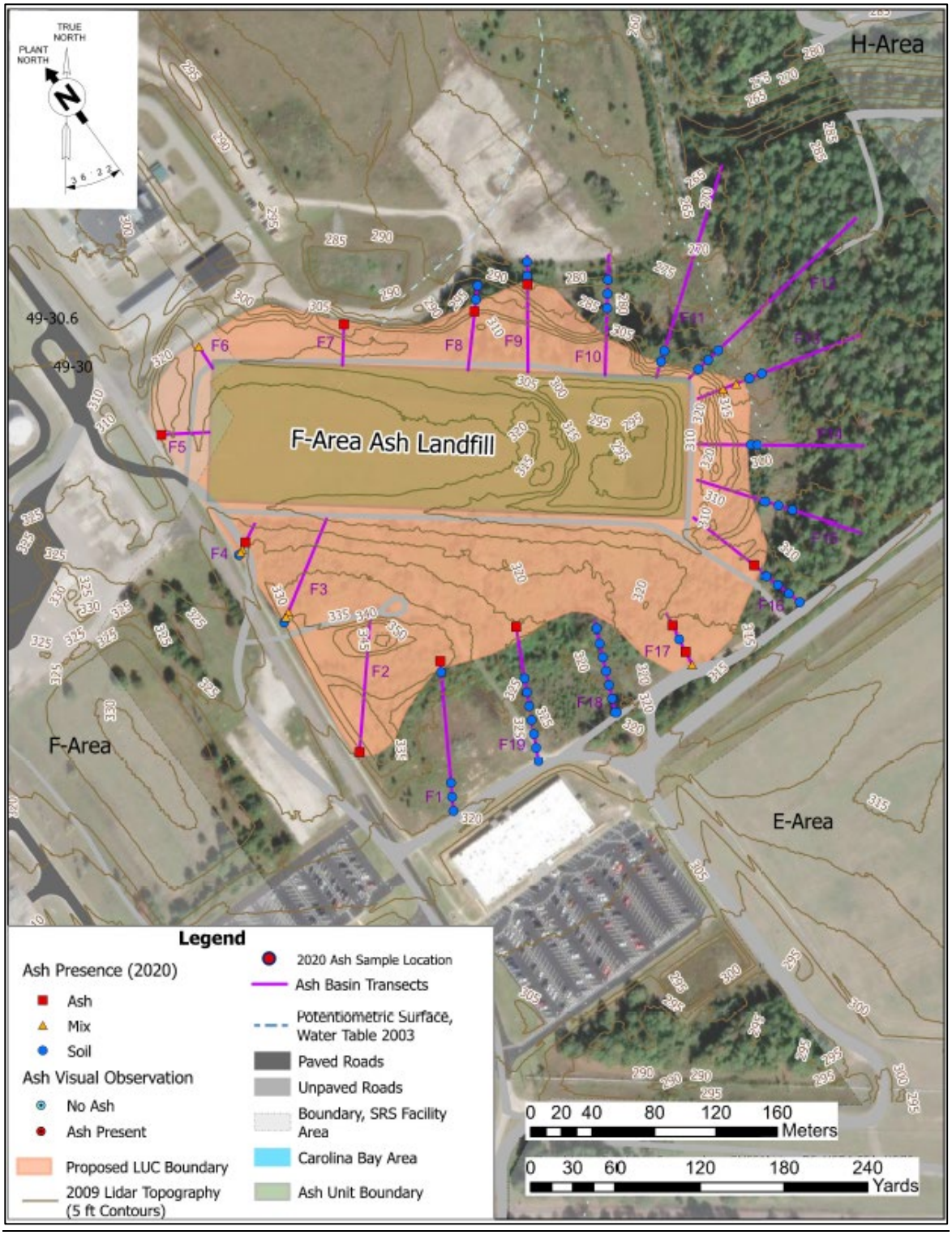

Figure 5. F-Area Ash Landfill OU Topography and Ash Observation Transects

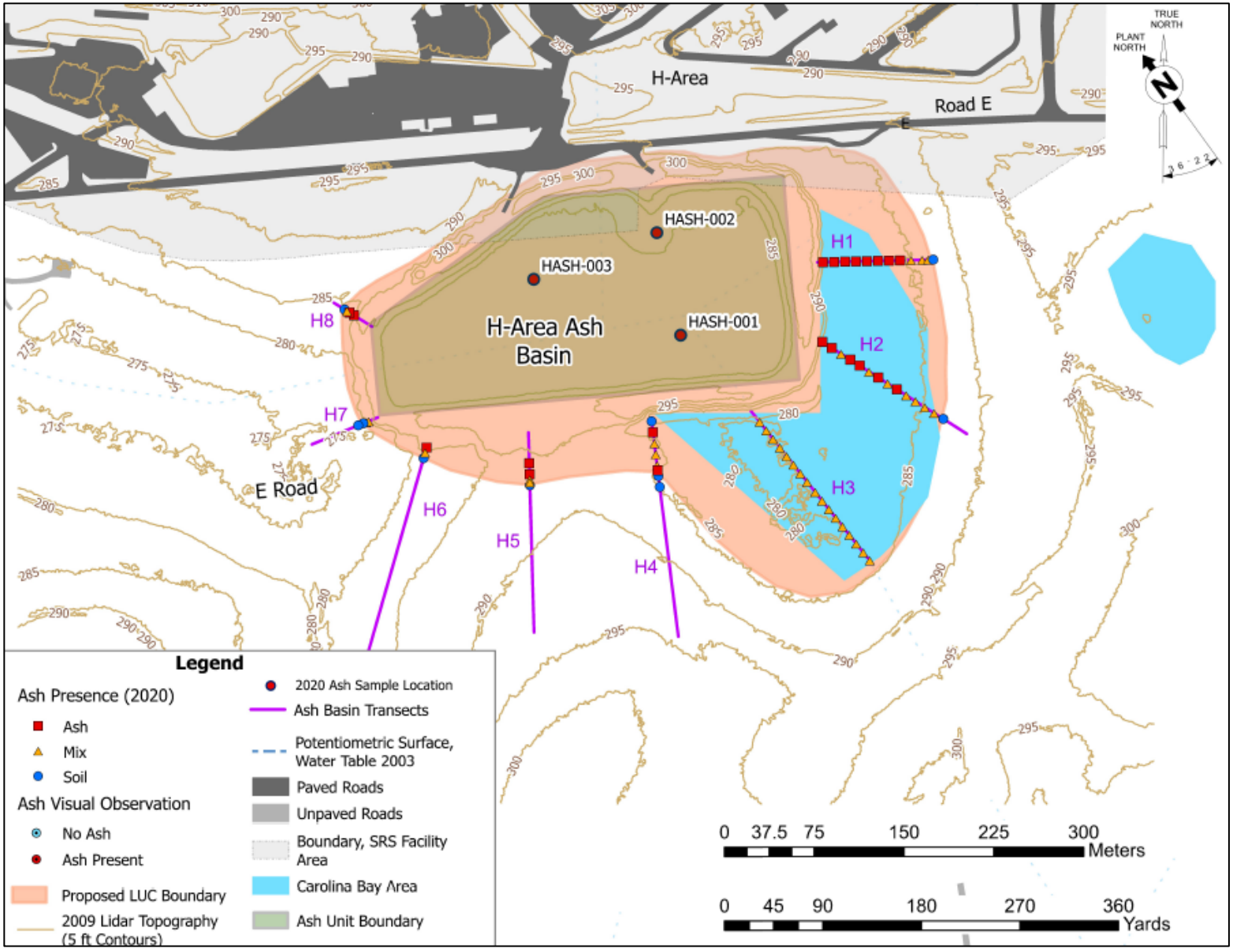

Figure 6. H-Area Ash Basin OU Topography and Ash Observation Transects

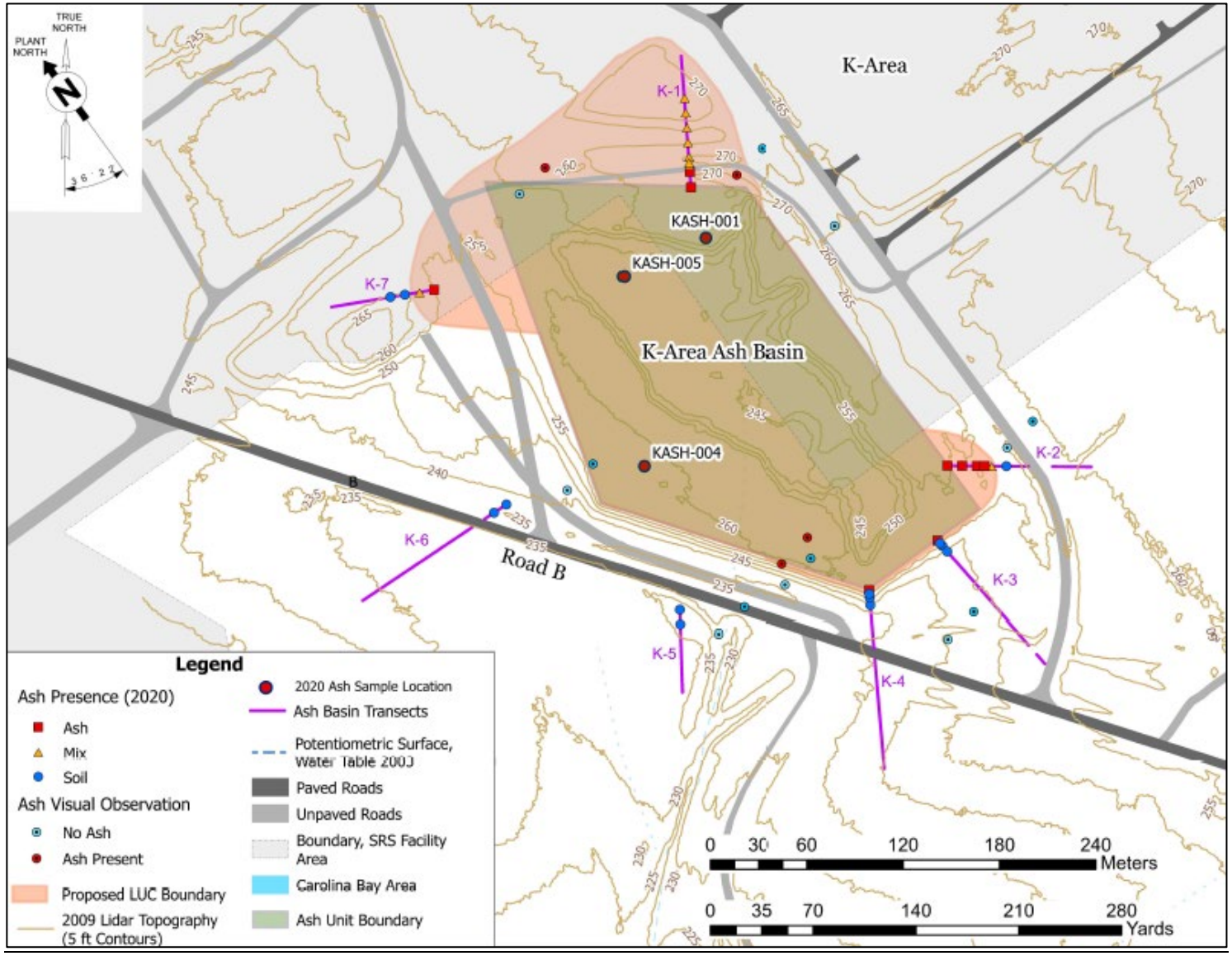

Figure 7. K-Area Ash Basin OU Topography and Ash Observation Transects

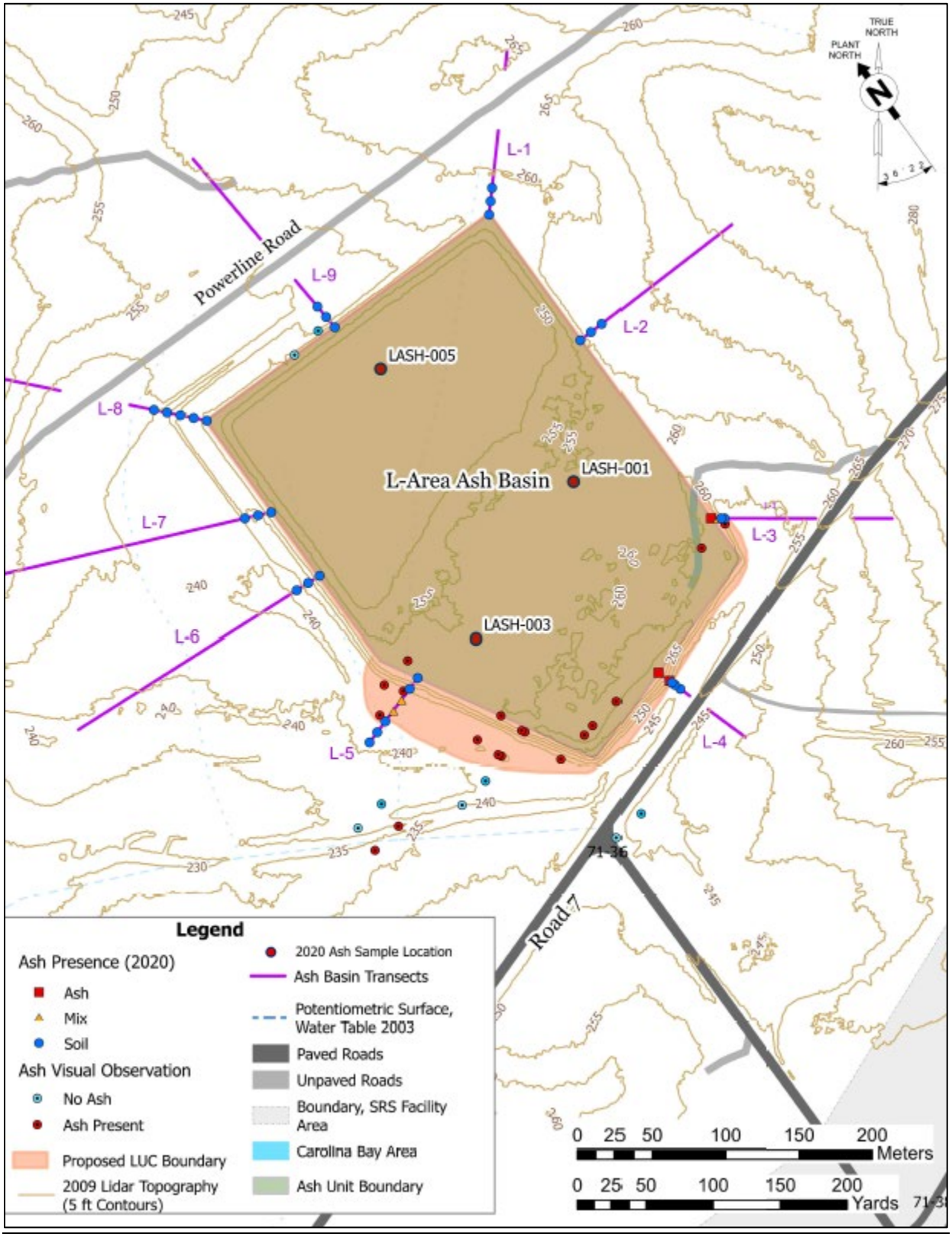

Figure 8. L-Area Ash Basin OU Topography and Ash Observation Transects

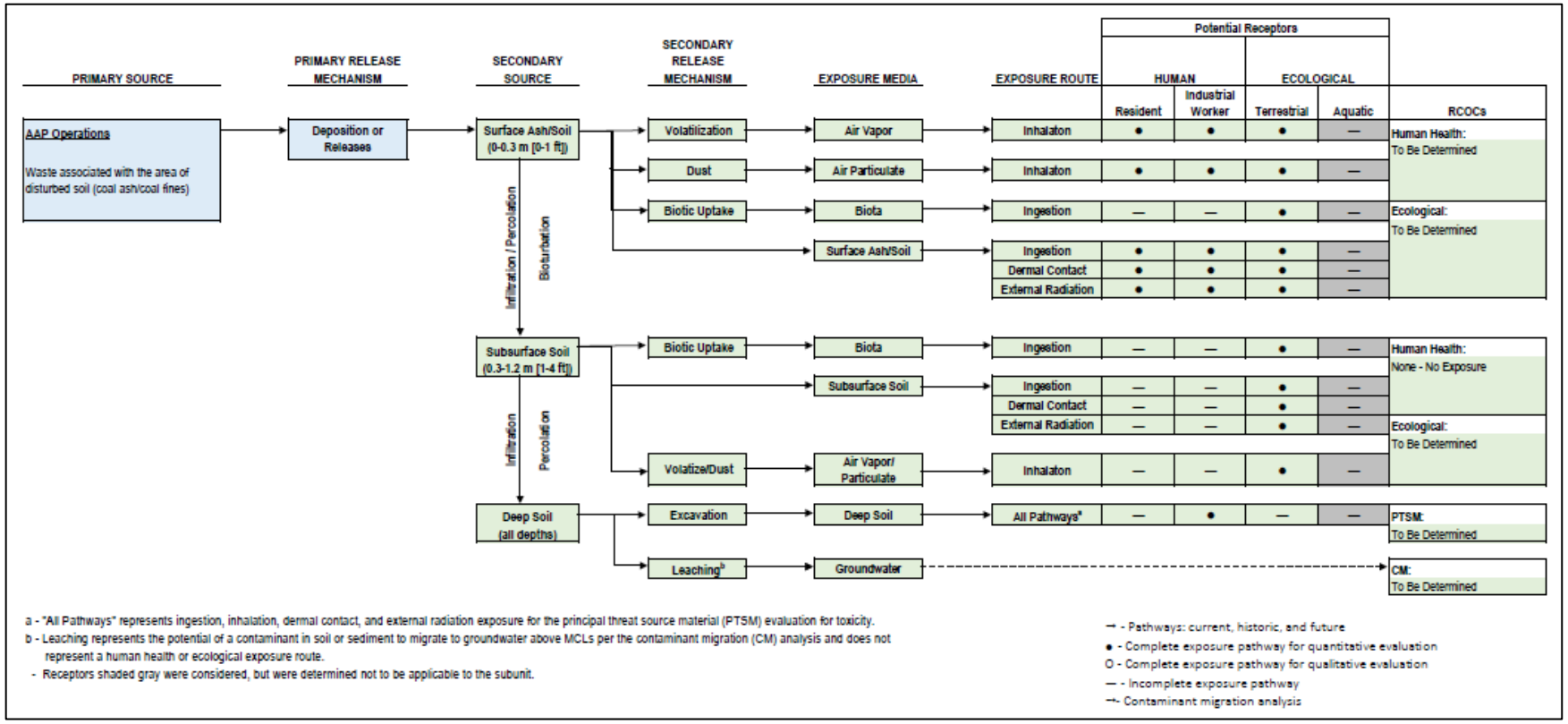

Figure 10. Preliminary CSM for the A-Area Ash Pile

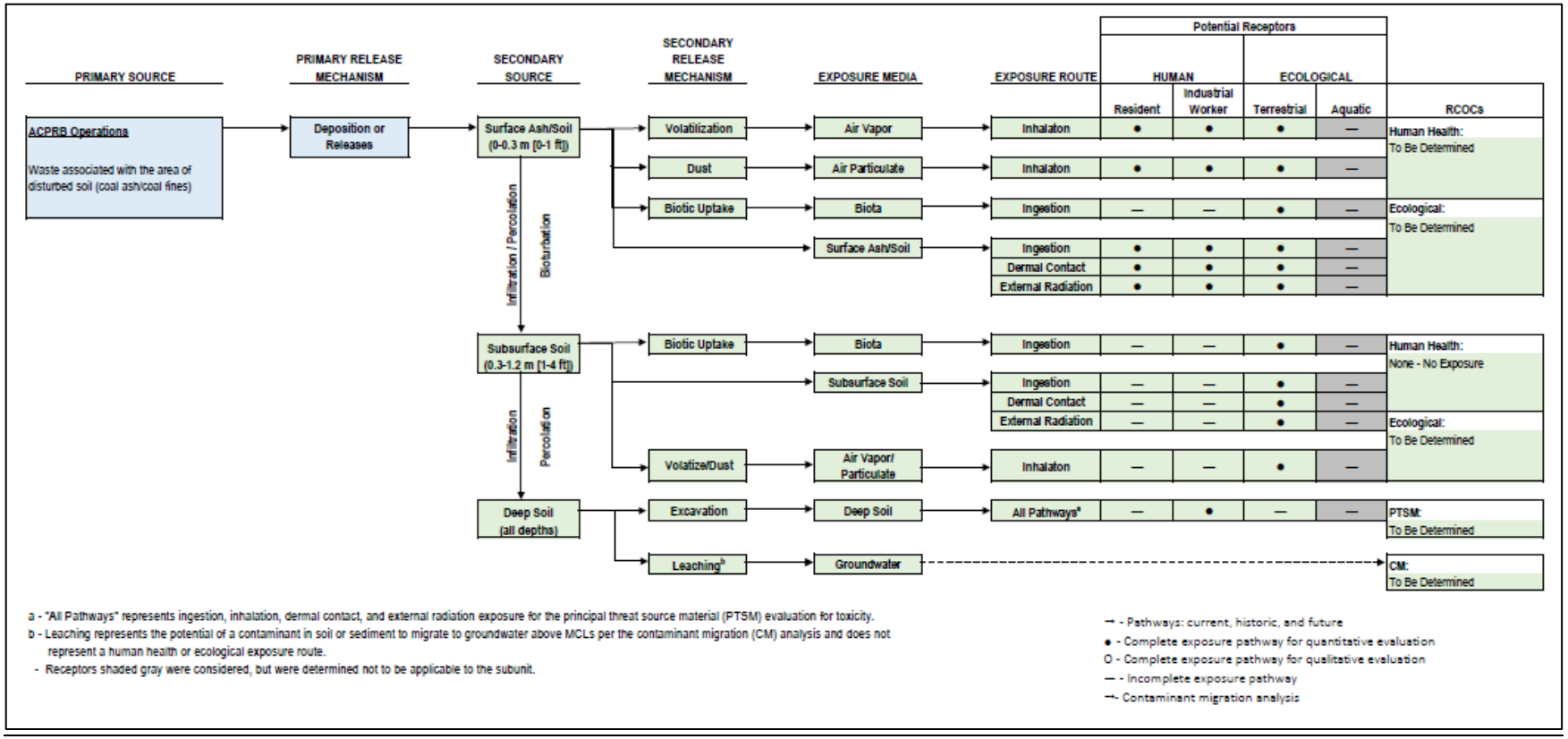

Figure 11. Preliminary CSM for the A-Area Coal Pile Runoff Basin

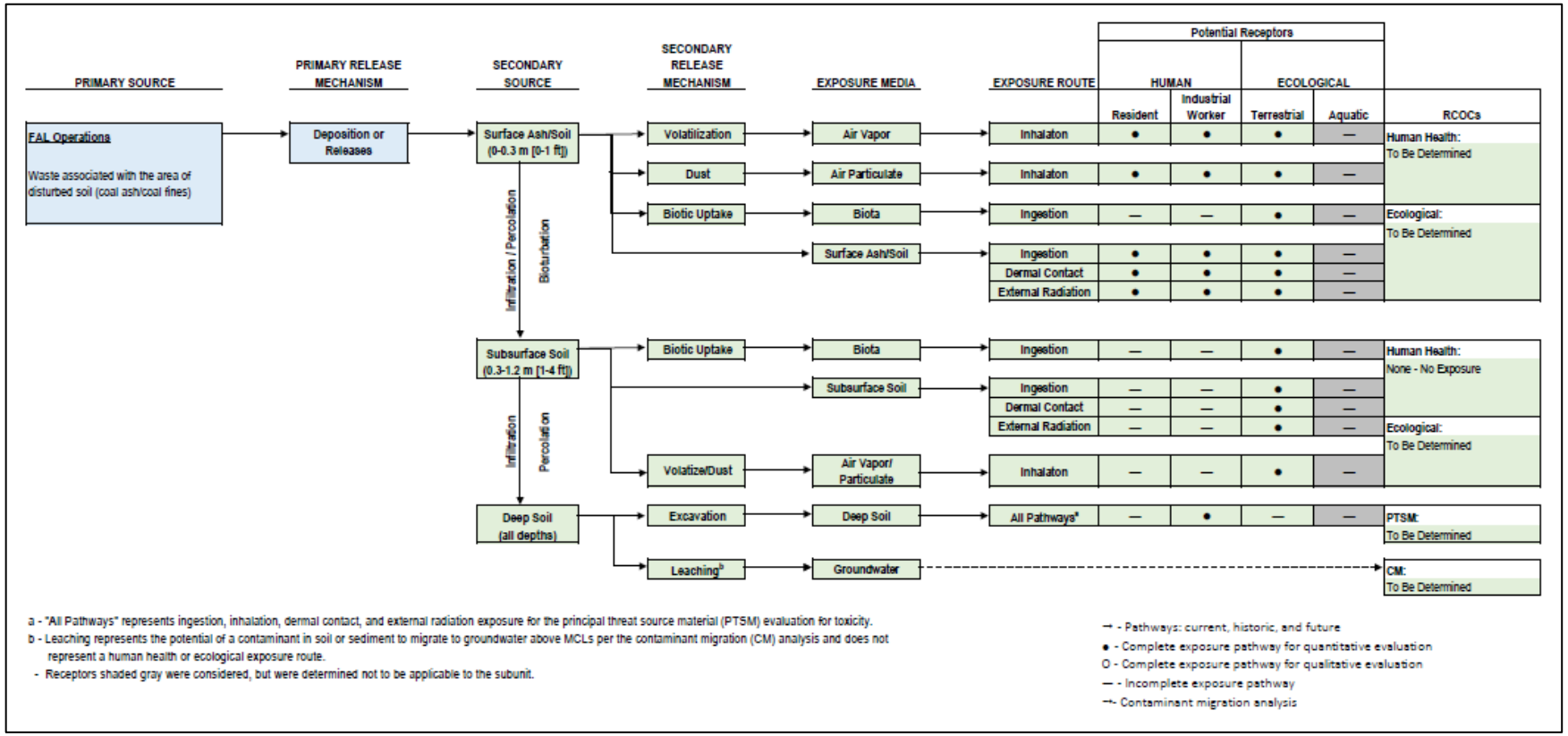

Figure 12. Preliminary CSM for F-Area Ash Landfill OU

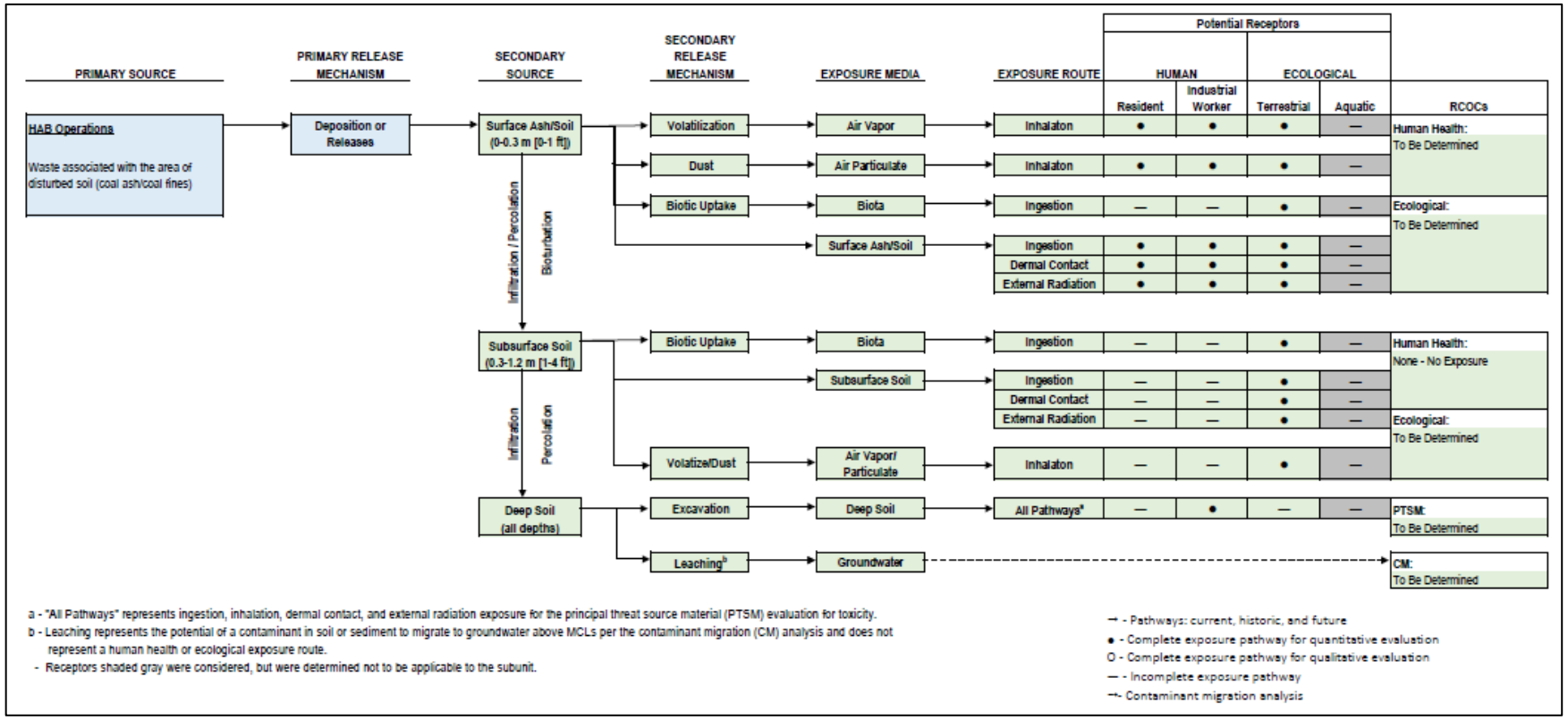

Figure 13. Preliminary CSM for H-Area Ash Basin OU

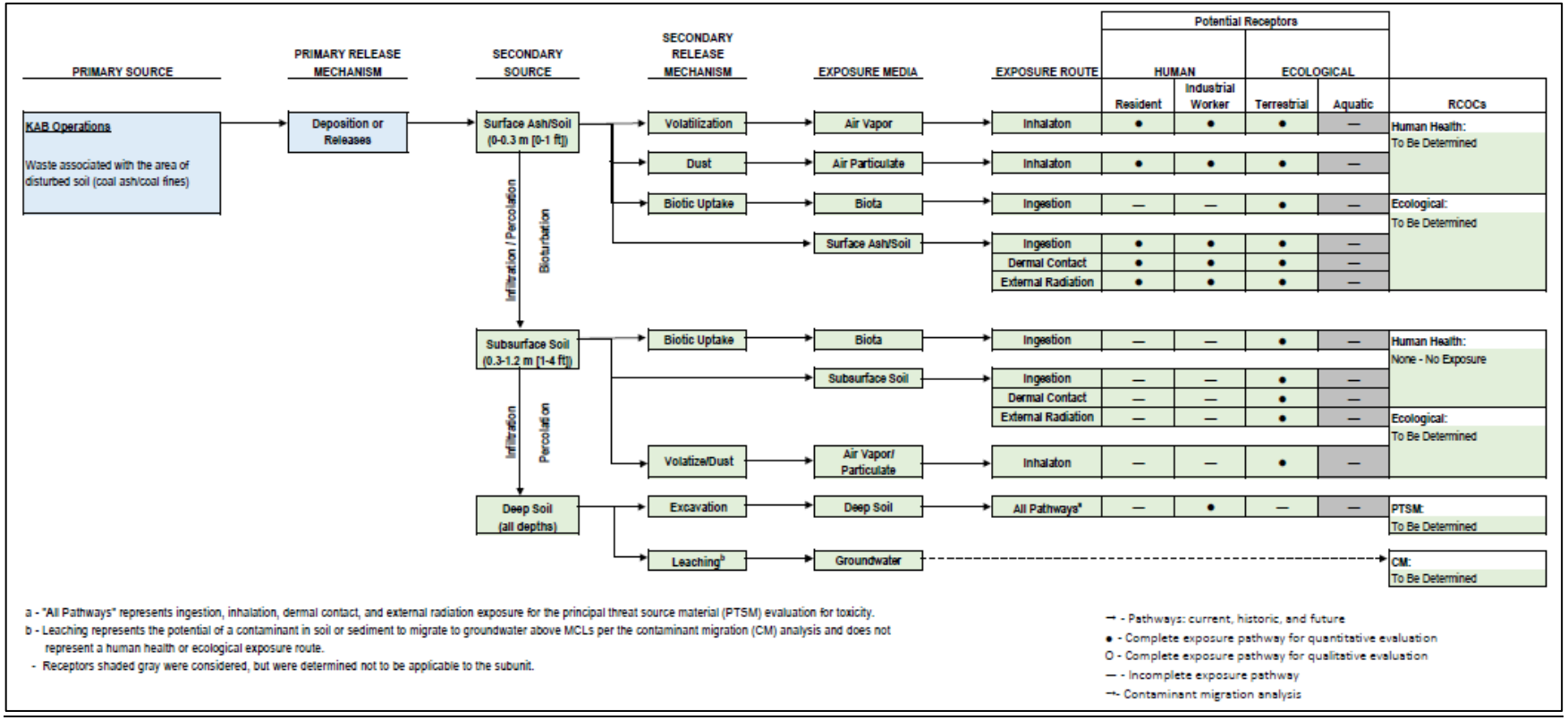

Figure 14. Preliminary CSM for K-Area Ash Basin OU

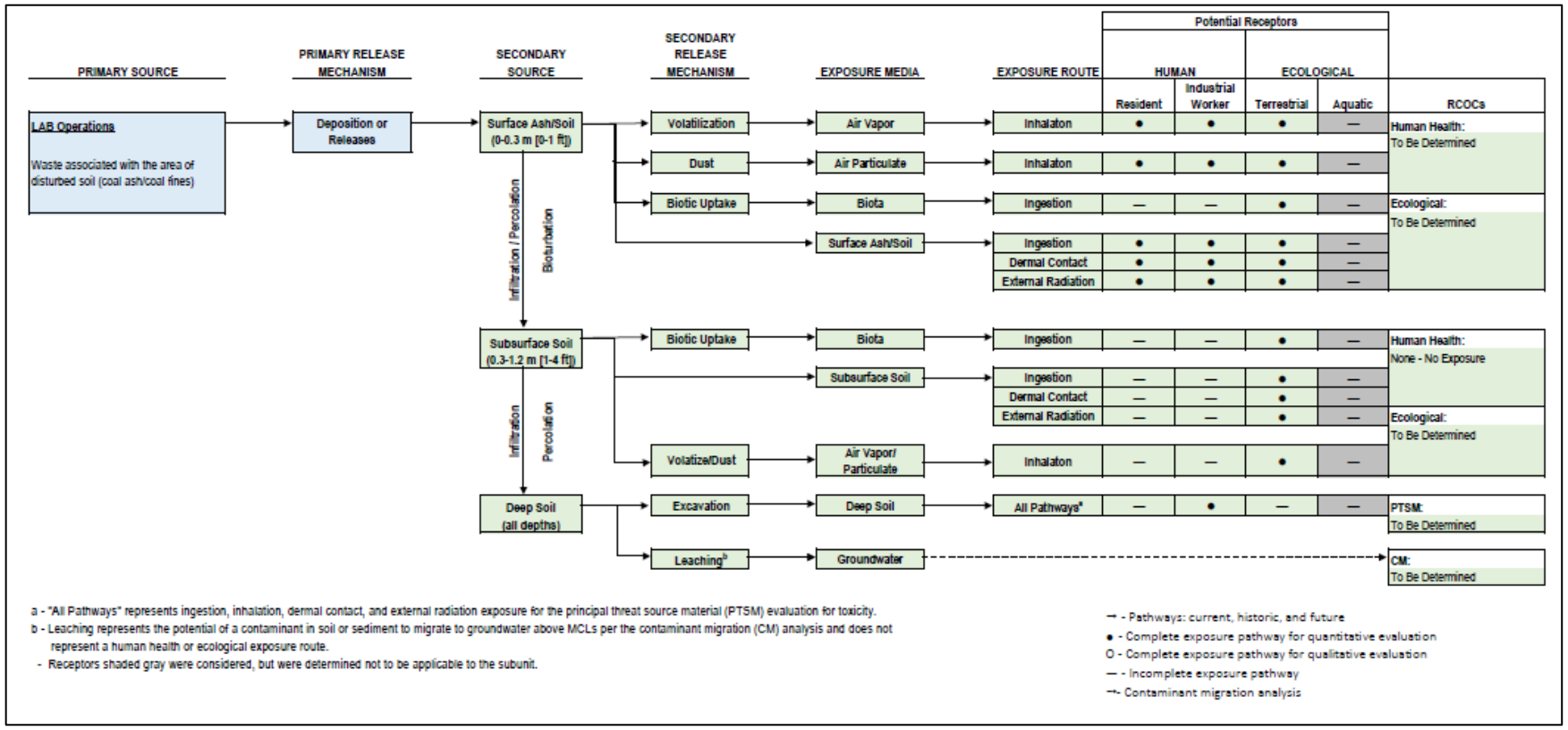

Figure 15. Preliminary CSM for L-Area Ash Basin OU

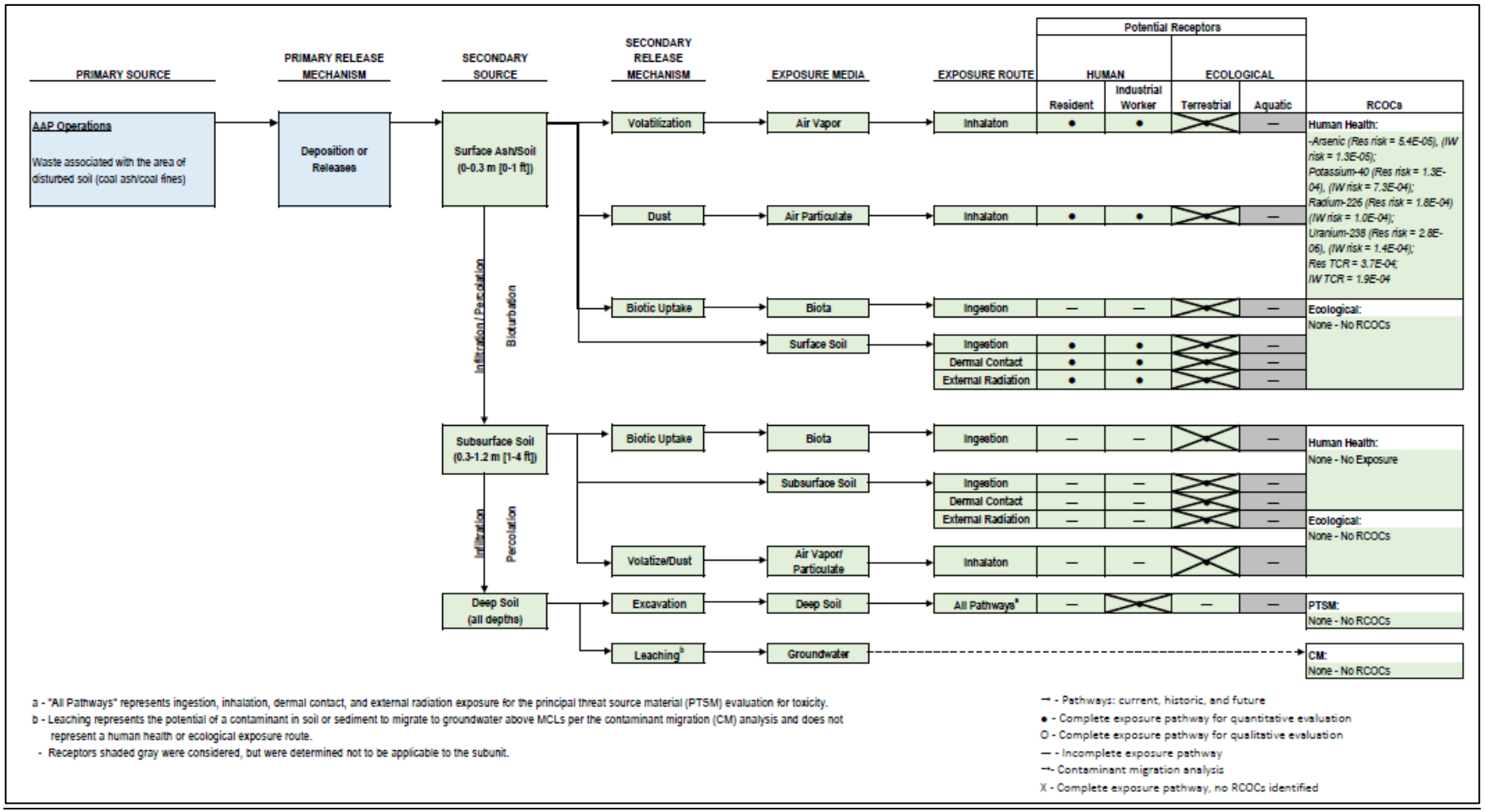

Figure 16. Refined CSM for the A-Area Ash Pile

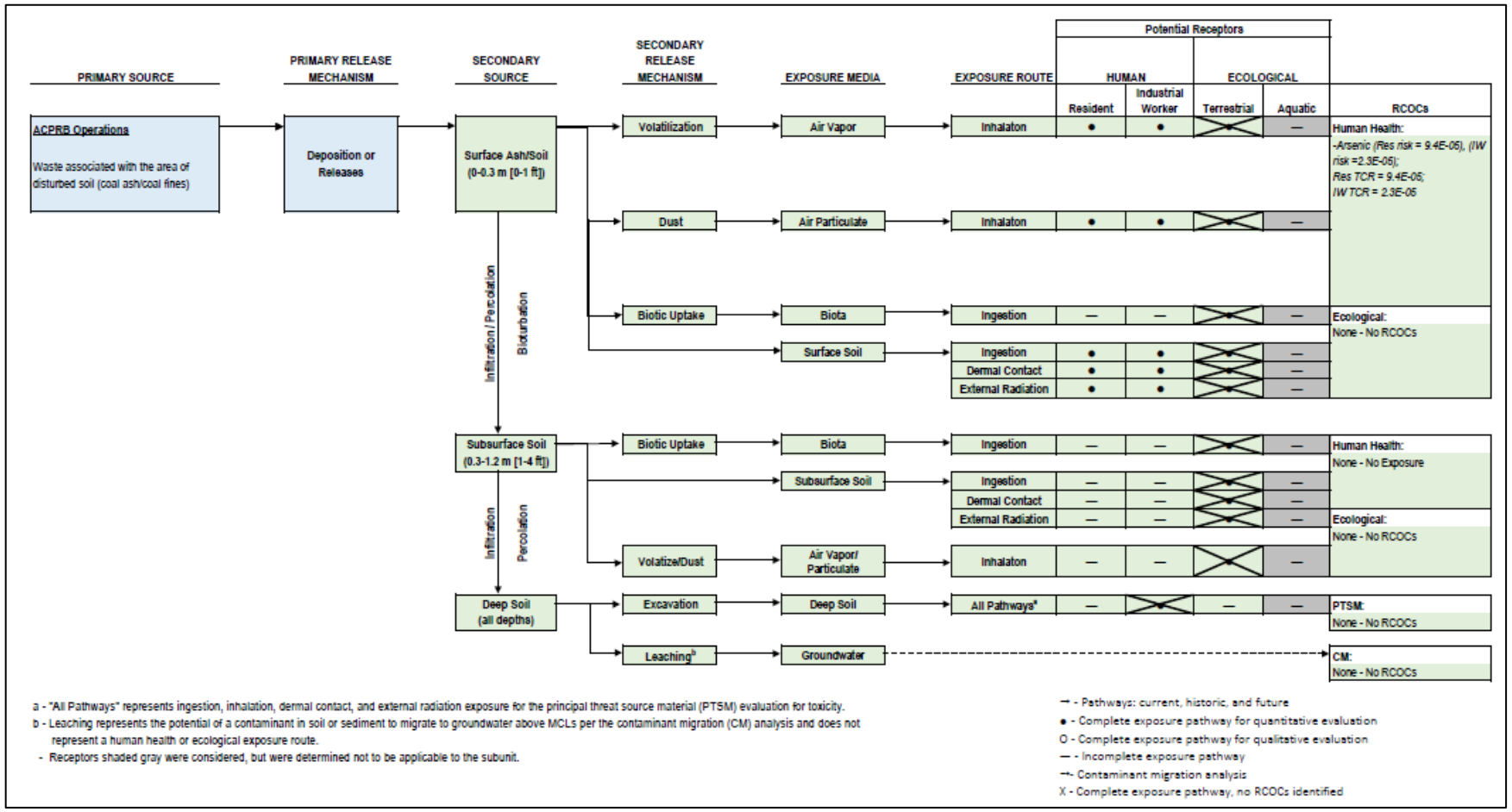

Figure 17. Refined CSM for the A-Area Coal Pile Runoff Basin

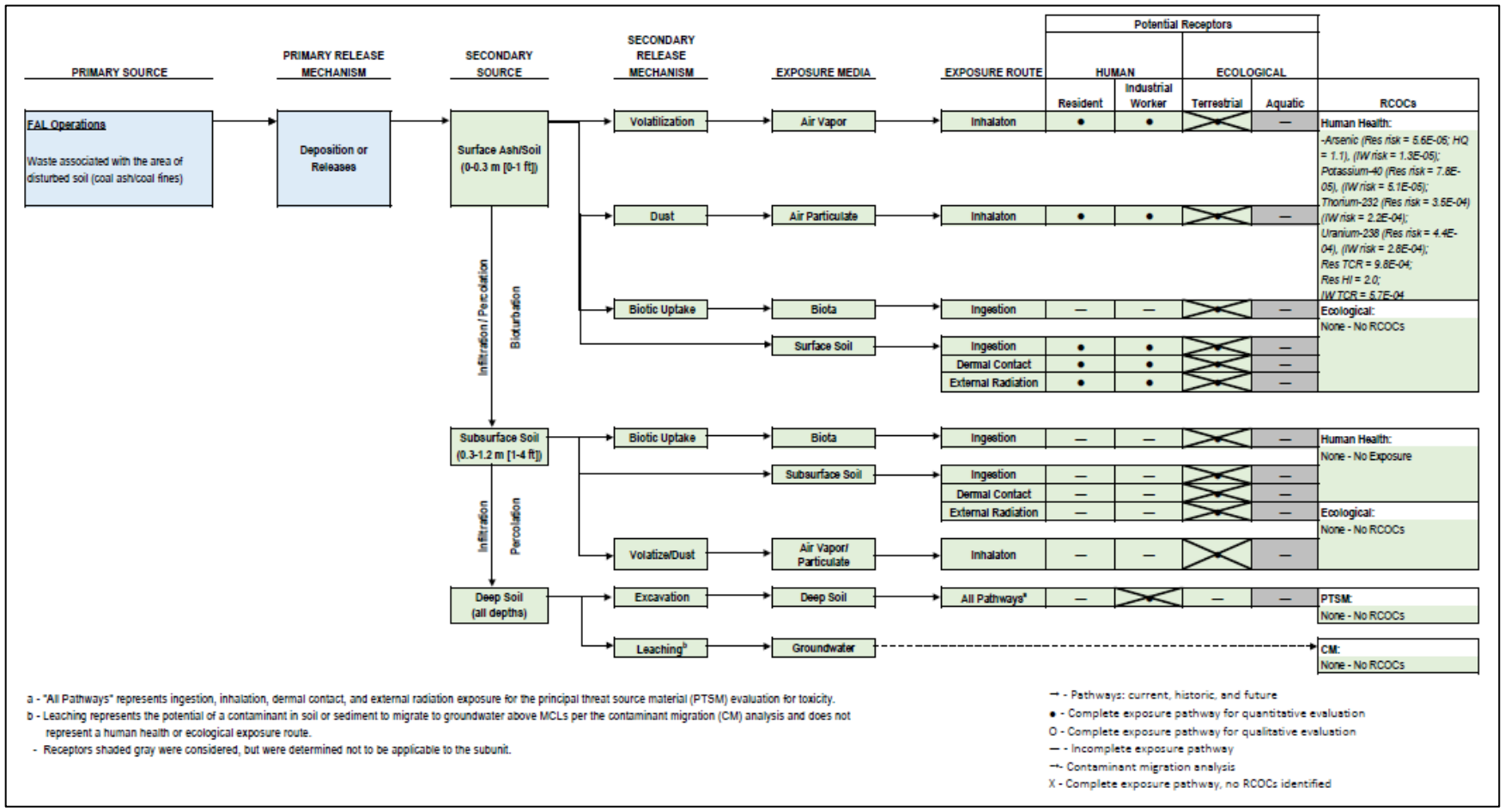

Figure 18. Refined CSM for F-Area Ash Landfill OU

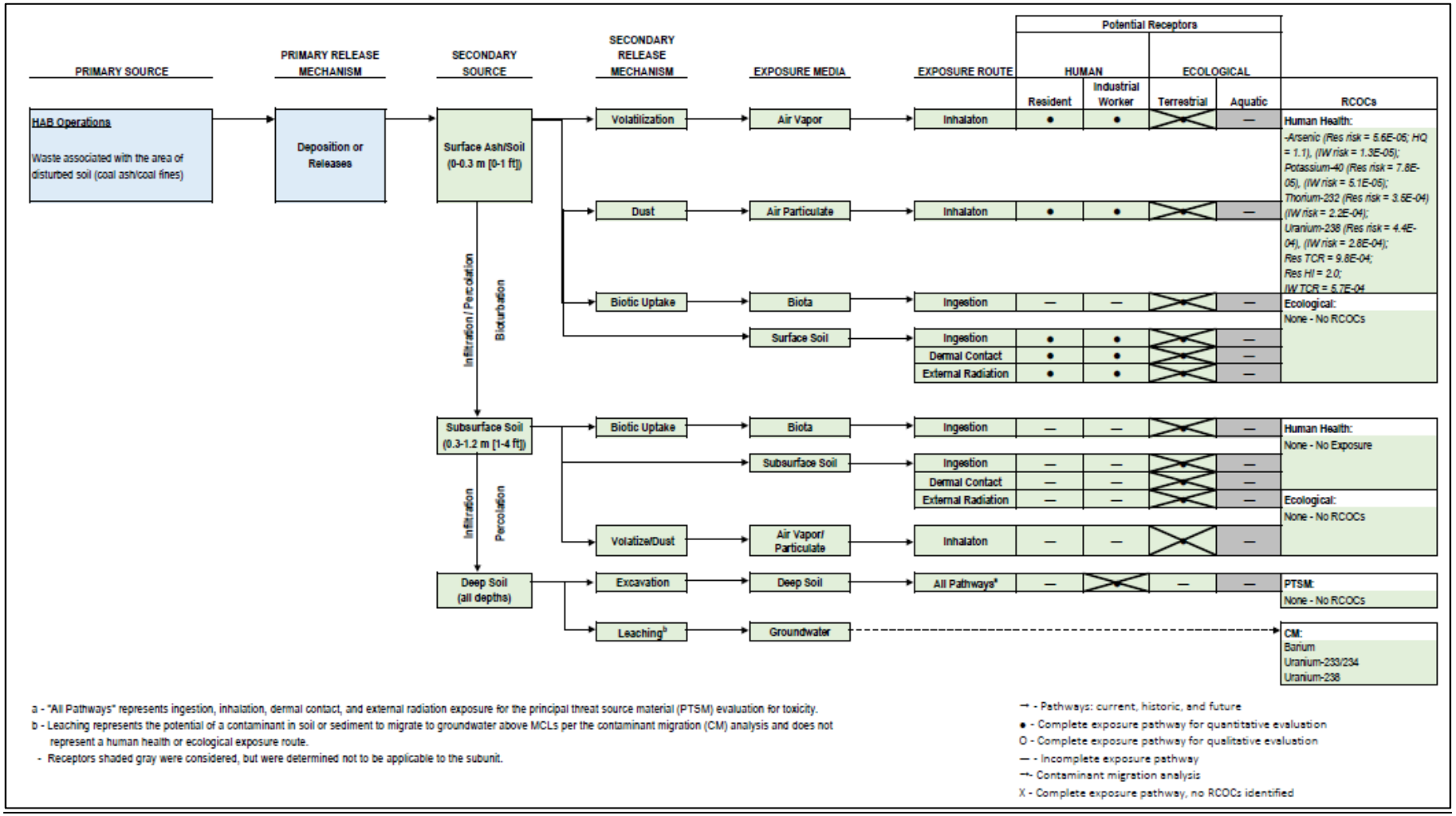

Figure 19. Refined CSM for H-Area Ash Basin OU

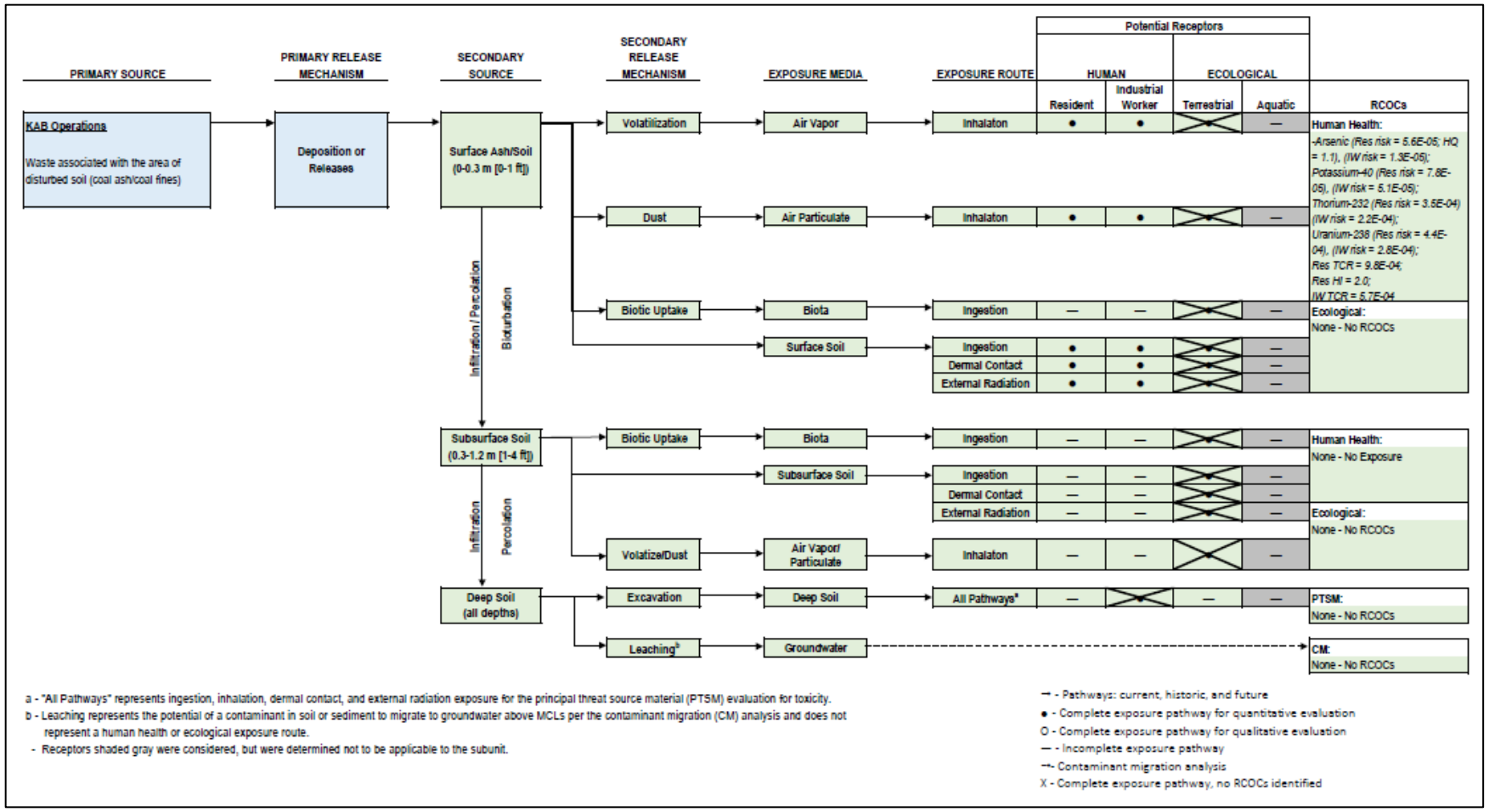

Figure 20. Refined CSM for K-Area Ash Basin OU

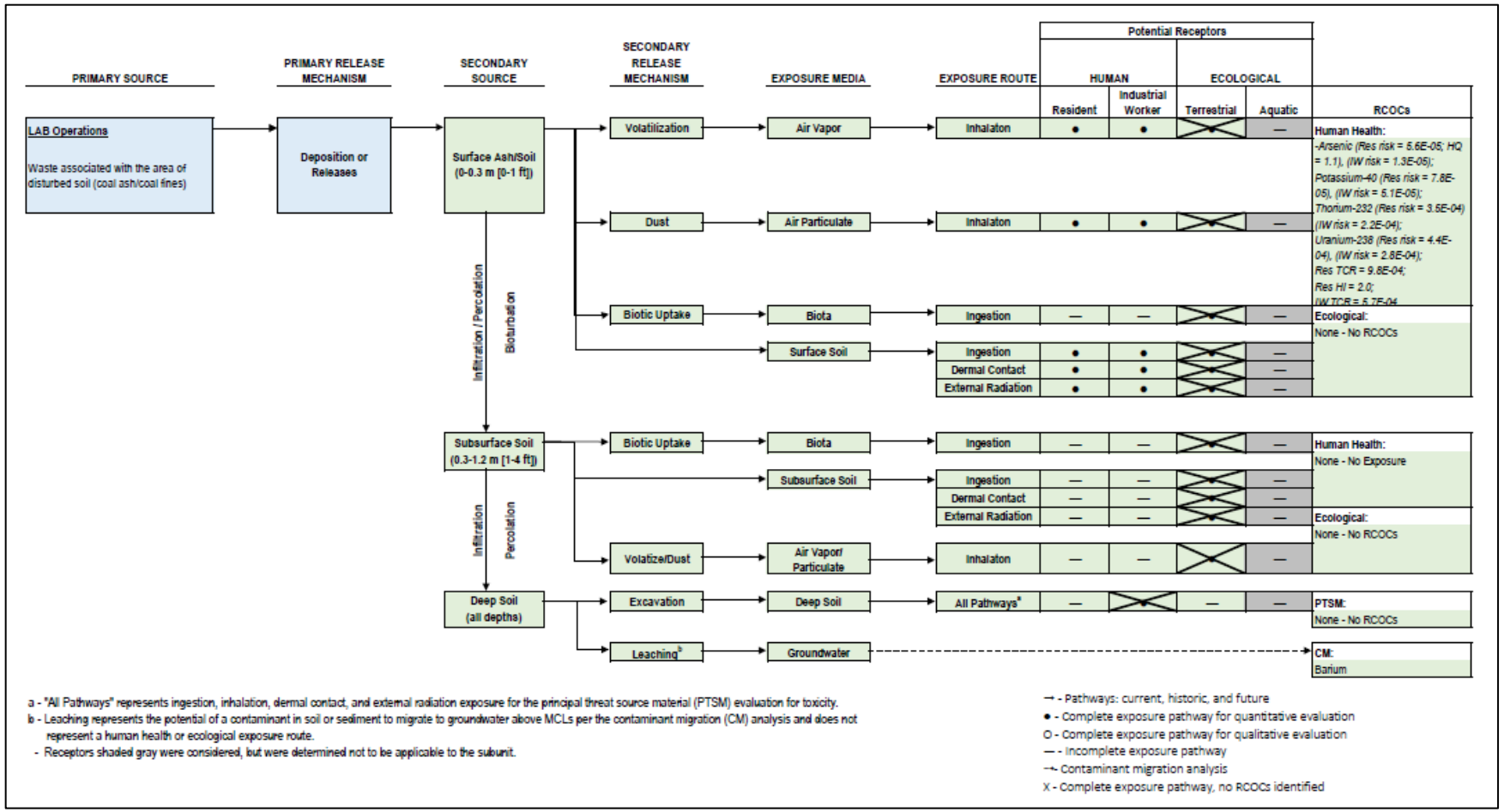

Figure 21. Refined CSM for L-Area Ash Basin OU

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 *(Continued)*

Subunit	RCOCs					
			HHRA			
	ARAR	CM [1]	Residential	Industrial	ERA	PTSM
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 pCi/L (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 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 %file[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	~~49.92~~52	~~25~~264.1
	Uranium-233/234	pCi/g	-	-	-	-	-	-	-	0.67	0.67	~~1.76~~1.20	~~1.76~~1.20
	Uranium-235	pCi/g	-	-	-	-	-	-	-	0.03	0.03	0.11	0.11
	Uranium-238	pCi/g	-	-	-	-	-	-	-	0.67	0.67	1.2~~90~~	1.9~~20~~
LAB	Barium	mg/ kg	-	-	-	-	-	-	-	75.3	75.3	~~25~~249.9	~~25~~275.3
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.

Table 5. Summary of the Remaining Coal Ash and Coal Fines Operable Units Cleanup Levels *(Continued/End)*

[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. No RCOCs identified (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 2.
[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.

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~~; readily implementable. Low cost~~.	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.~~Low cost~~.	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. Low cost.~~	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)*

General Response Action	Remedial Technology	Effectiveness	Implementability	Cost	Technology Status
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 l~~L~~ong term. ~~e~~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.

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 ~~presents the data summary~~ 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.

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 (~~i.~~e.g., using the average or 95% UCL concentration when the maximum value is not representative of a large OU as a whole~~; using a more representative source thickness for a constituent only observed in surface soils~~). 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 remediation 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

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. ~~(Table B-13). The detected sample was from the LAB OU.~~ The detected~~ion~~ result and the MDAs for all consolidated samples are ~~is~~ 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 $SSL_{T1/2}$ (i.e., CM PRG) determined for uranium-235 at the HAB OU is 3.36E-02 pCi/g. ~~Uranium is a naturally occurring constituent that is common in the environment. Uranium-235 was not retained as a CM RCOC for the HAB OU based on the following lines of evidence:~~

- ~~It was only detected in one of nine consolidated ash/soil samples with an estimated value (J-qualified).~~
- ~~It is a naturally occurring constituent that is common in SRS background soils.~~

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

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

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

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:

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

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.

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 ~~threatened, endangered, and sensitive (~~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

- ~~-~~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 thesholds, 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

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.

F-1. INTRODUCTION

Risk-based cleanup levels, i.e., preliminary remedial 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. ~~No~~ There were CM RCOCs ~~were~~ identified for the HAB OU (barium, uranium-233/234, uranium-235, and uranium-238) and the LAB OU (barium). ~~remaining coal ash and coal fines OUs. Therefore,~~ CM PRGs are presented in Table B-15 of ~~not developed in this~~ Aappendix 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.

Table F-1. Human Health Risk-Based Preliminary Remedial 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.