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APPENDIX A: PERFORMANCE ASSESSMENT SUPPORTING DOCUMENTS AND KEY ASSUMPTIONS

A.1 REPORTS PREPARED IN SUPPORT OF THE E-AREA LOW-LEVEL WASTE FACILITY SINCE ISSUANCE OF THE 2008 PERFORMANCE ASSESSMENT

Table A-1, Table A-2, and Table A-3, respectively, list SAs, UDQEs, and other analyses and assessments prepared in support of the ELLWF since the previous ELLWF PA was issued in early 2008.

A.2 KEY ASSUMPTIONS

Table A-4 lists key assumptions made in the analysis of the various transport pathways. The table is organized by topical area or specific pathway and disposal unit. Assumptions that need to be protected by ELLWF Operations to maintain the radioactive waste management basis for the facility are identified in the *Ops Parameter* column. *Ops Parameters* represent those key assumptions that actively require ELLWF Operations actions. For example, the placement of waste within a given DU must reside entirely within that DUs waste zone footprint. Operating outside these parameter settings or conditions has the potential to increase dose impacts at the POAs; therefore, a UDQE should be performed to assess the impact for continued operations. *Ops Parameters* apply to only current or future required ELLWF Operations actions. For example, operational stormwater runoff covers were placed over CIG trench segments in prior years and new or additional covers will not be required in the future; however, the existing covers will potentially require maintenance in the out years and thus are treated as an *Ops Parameter*. Conversely, past actions that do not require any future activity are not considered an *Ops Parameter*.

The table also contains key assumptions that define disposal system or model properties that are outside of operational controls (e.g., hydraulic properties of the subsurface soil zones) but which are important to PA analyses. If the source of the assumption, or a more complete description, is provided outside the PA, then the appropriate reference is identified at the end of the text within the first column. If a section, table, or figure is referenced in the *Key Assumption* column, the source of that citation is provided. If no reference is provided, the section, table, or figure number cited is understood to be within this PA report itself.

Table A-1. List of Special Analyses Prepared in Support of E-Area Low-Level Waste Facility Since Issuance of 2008 Performance Assessment

Supporting Special Analysis Reference in Chronological Order	Summary
Collard, L. B., and Hamm, L. L. (2008). "Special Analysis of Operational Stormwater Runoff Covers Over Slit Trenches." SRNL-STI-2008-00397, Rev. 0. Savannah River National Laboratory, Aiken, SC.	SWM commissioned this SA to determine the effects of placing operational stormwater runoff covers over ST DUs ST01 through ST07 at about years 5, 10, and 15 of the 30-year operational period. Covering changed the movement of contaminants to the water table and the hypothetical well. Early movements typically decreased because the cover decreased the flow of water from the surface through the contaminants. Later movements typically increased because less of the inventory had been released than for the uncovered cases analyzed in the PA. These effects on contaminant movement translated into higher SA-calculated limits relative to PA limits in the early years and some lower SA-calculated limits relative to PA limits in the later years. Because the lower of the two sets of limits was always selected as the operational limit, the net effect was to lower limits in the later years (typically 100 years and later). Earlier covers at 5 years magnified the changes.
Swingle, R. F., II (2008). "Special Analysis: Disposal of Tritium Containing IP-2 Boxes in the E-Area Low Level Waste Facility Intermediate Level Vault." SRNL-STI-2008-00453, Rev. 0. Savannah River National Laboratory, Aiken, SC. December 23, 2008.	SRNL recommends that the disposal of the Defense Programs Classified Waste Stream be allowed in the ILV as a SWF. The H-3 inventory limit of 4.6E+08 Ci is to be used as the air pathway limit for the SWF. The generic H-3 GW protection and all-pathways limits will continue to be used for the new SWF. Given the bounding anticipated inventory of H-3 in this waste stream, the maximum anticipated dose to MEI is ~0.22 mrem yr^{-1} which is well below the PO of 10 mrem yr^{-1}. The maximum fraction of limit is anticipated to be 0.022. This should not restrict disposal of future waste to the ILV. Since the GW protection beta-gamma limit for generic H-3 is less than the new SWF air pathway limit, the GW beta-gamma limit will become the governing limit for this SWF. The anticipated final inventory of 1E+07 Ci is less than the GW beta-gamma limit of 7.5E+07 Ci. Therefore, the limiting SOF based on the GW protection beta-gamma limit for this waste form is anticipated to be 0.13.
Collard, L. B., Hamm, L. L., and Smith, F. G. (2010). "Special Analysis of Tritium Disposal Limits for E-Area Slit Trench 4." SRNL-STI-2010-00263, Rev. 0. Savannah River National Laboratory, Aiken, SC. May 3, 2010.	Results from this SA show that the total allowable disposal limit for H-3 in ST04 is 2,500 Ci from the beta-gamma limit at 12-100 years. The large increase in disposal limits for H-3 in ST04 is a direct result of the plan to place an operational cover over ST03 and ST04 by 9/30/2011. The modeling conclusively demonstrates that the H-3 inventory from the two waste packages remaining in ST04 will be well within revised PA limits.
Hamm, L. L., and Smith, F. G. (2010). "Special Analysis for Slit Trench Disposal of the Heavy Water Components Test Reactor." SRNL-STI-2010-00574, Rev. 0. Savannah River National Laboratory, Aiken, SC.	This SA was undertaken to address only those radionuclides remaining in HWCTR that significantly contribute to producing a SOF>1 based on the generic disposal limits for the East Slit Trenches. A screening was performed to identify those radionuclides contributing >1% to the SOFs for further analysis. As a result, ten radionuclides requiring SWF consideration were addressed by this SA. The SA employs a coupled decay-corrosion source term model to produce an accurate estimate of inventory for these radionuclides at the projected time of burial in January 2011. However, inventory estimates for these SWF radionuclides calculated in December 2009 by Vinson et al. (2010) can be used as the WITS inventory to produce conservative estimates for sum-of-fraction contributions. No new SWFs for the non-GW pathways were judged to be warranted. The inventory limits for each non-GW pathway remain set to their values as provided in PA2008 (WSRC, 2008).
Hiergesell, R. A., and Taylor, G. A. (2011). "Special Analysis: Air Pathway Modeling of E-Area Low-Level Waste Facility." SRNL-STI-2011-00327, Rev. 0. Savannah River National Laboratory, Aiken, SC.	This SA was initiated to address a concern expressed by DOE's LFRG Review that the potential for overlapping of atmospheric plumes, emanating from the soil surface above the ELLWF, would contribute to dose received by a MOP during the IC period. Even though the full suite of potentially volatile radionuclides was included in the model, the improved ARM computed a zero flux at the land surface for all of the radionuclides except C-14 and H-3. The main factors in this phenomenon are the tendency of those radionuclides to partition into the available porewater of the disposal facility and overlying layers during the simulation and radioactive decay. Thus, these two radionuclides are the only ones for which new atmospheric pathway disposal limits are presented for the ELLWF disposal facilities.
Swingle, R. F. (2011). "Revision of the ELLWF Limits Database Incorporating the HWCTR Special Analysis (Rev. 2011-1)." SRNL-L3100-2011-00041, Rev. 0. Savannah River National Laboratory, Aiken, SC. March 3, 2011.	New GW protection beta-gamma, all-pathways, air pathway, and IHI pathway limits for demolition waste based on the HWCTR SWF SA conducted by Hamm and Smith (2010) are incorporated into the ELLWF Disposal Limits database.
Swingle, R. F. (2011). "Revision of the ELLWF Limits Database Incorporating the Air Pathway Special Analysis (Revision 2011-2)." SRNL-L3200-2011-00004, Rev. 0. Savannah River National Laboratory, Aiken, SC. October 4, 2011.	New air pathway limits from the 2011 Air Pathway SA (Hiergesell and Taylor, 2011) for all DUs are incorporated into the ELLWF Disposal Limits database.
Hamm, L. L., Collard, L. B., Aleman, S. E., Gorensek, M. B., and Butcher, B. T. (2012). "Special Analysis for Slit Trench Disposal of the Reactor Process Heat Exchangers." SRNL-STI-2012-00321, Rev. 0. Savannah River National Laboratory, Aiken, SC.	This SA evaluated the performance of 19 heat exchangers to be disposed in ST09. Although the 19 heat exchangers were never decontaminated, the majority of the radionuclides in the heat exchanger inventory list were determined to be acceptable for burial because they are less than the "generic" waste form inventory limits given in PA2008 (WSRC, 2008). However, as generic waste, the H-3 and C-14 inventories resulted in unacceptable SOFs. Initial scoping analyses performed by SRNL indicated that if alterations were made to certain external nozzles to mitigate various potential leak paths, acceptable SOFs could be achieved through the use of a SWF. This SA provides the technical basis for this new SWF and provides the inventory limits for H-3 and C-14 for the 19 heat exchangers such that they can be disposed in ST09. This SWF is limited to the 19 heat exchangers in ST09 and applies for H-3 and C-14, which are designated as H-3X and C-14X, respectively.
Swingle, R. F. (2012). "Special Analysis: Revised Groundwater Protection and All-Pathways Limits for E-Area Low-Level Waste Facility Trenches." SRNL-STI-2012-00466, Rev. 0. Savannah River National Laboratory, Aiken, SC. August 2012.	In the process of performing an SA to evaluate the disposal of reactor heat exchangers in the West ST group (Hamm et al., 2012), SRNL recognized that the different sizes, geometry, and orientation of the ST units in that group might not be adequately represented by the application of a single set of GW limits. SRNL concluded that adjustments needed to be made to GW limits (Butcher and Hiergesell, 2012) to account for these differences. SRNL expanded their review to assess all ELLWF disposal groups and determined that ST06 through ST21 and ET01 and ET02 needed to be revised. This revision only applies to limits generated from the GW pathway (i.e., Beta-Gamma, Alpha, Radium, Uranium, and All-Pathways). Intruder, air, and radon pathway limits are not impacted. ST01 through ST05 in the Center ST group received a post-closure analysis (Collard et al., 2011) which demonstrated that these STs will not exceed POs. Revised GW limits for ST06 through ST21 and ET01 and ET02 are presented in this SA.

Table A-1 (cont'd). List of Special Analyses Prepared in Support of E-Area Low-Level Waste Facility Since Issuance of 2008 Performance Assessment

Supporting Special Analysis Reference in Chronological Order	Summary
Smith, F. G., III, and Hamm, L. L. (2014). "Special Analysis: Revised Disposal Limits for the Low Activity Waste Vault." SRNL-STI-2014-00289, Rev. 0. Savannah River National Laboratory, Aiken, SC. September 2014.	Disposal limit calculations for the LAWV in PA2008 were based on preliminary, rather than final, model output, and that an inaccurate timeline was employed in the analysis. These issues have been addressed and new GW protection and all-pathways limits are established by this SA. The single negative impact is to the H-3 all-pathways limit, which is reduced by 50%. However, the H-3 all-pathways limit is very high relative to the controlling beta-gamma pathway limit which is two-orders of magnitude lower. There is no adverse impact on waste already disposed in the LAWV and future disposals should be unaffected by this change based on the insignificant contribution of H-3 to the SOF for the limiting BG pathway group. Disposal limits for all other LAWV radionuclides and dose pathways remained the same or increased.
Hamm, L. L., Aleman, S. E., Danielson, T. L., and Butcher, B. T. (2018). "Special Analysis: Impact of Updated GSA Flow Model on E-Area Low-Level Waste Facility Groundwater Performance." SRNL-STI-2018-00624, Rev. 0. Savannah River National Laboratory, Aiken, SC.	GW flow directions in ELLWF STs, ETs, and the LAWV notably changed in the new 2018 GSA flow model (Flach, 2019). Updated flow directions in the model produced a higher degree of plume overlap for DUs in the southeastern portion of E-Area than had been predicted in PA2008 (WSRC, 2008). Based on deterministic and stochastic analyses, results from the SA show that the likelihood of exceeding an absolute SOF greater than one, while operating ELLWF under its current WITS inventory limits, is exceedingly small. Three interim measures were imposed on trench operations in ET02 and ST14 during the preparation of this SA. Based on these new operational constraints and the amount of margin observed in the deterministic and stochastic analyses, SRNL determined that SWM can continue to use the current WITS inventory limits for the DU's that were the subject of this analysis and be confident that the DOE O 435.1 GW protection requirement and GW POs will not be exceeded.

Table A-2. List of Unreviewed Disposal Question Evaluations Prepared in Support of E-Area Low-Level Waste Facility Since Issuance of 2008 Performance Assessment

Supporting Unreviewed Disposal Question Evaluations Reference in Chronological Order	Summary
Swingle, R. F., II (2008). "Unreviewed Disposal Question Evaluation: High Curie Content Waste Container in the E-Area Low Level Waste Facility Intermediate Level Vault." SRNL-TR-2008-00316, Rev. 0. Savannah River National Laboratory, Aiken, SC. December 15, 2008.	During a review of the inputs and assumptions prior to implementation of the new limits from the 2008 revision of the ELLWF PA, SWM determined that one B-12 Box (RD007710) exceeded the 5% SOF administrative guide. This container was found to contain 5.9 % of the allowable SOF for the GW protection alpha inventory limit for the 200 to 1,100-year timeframe. One assumption in the PA modeling used to determine GW protection limits is that all radionuclides are uniformly distributed within the DU. The 5% SOF administrative guidance was developed to protect against potential localized high radionuclide concentration in the GW. An SRNL review of the development of the GW protection limits for PA2008 showed that this high-SOF container in the ILV will not result in a “hot spot” in the GW alpha concentration. Therefore, this container does not compromise the assumptions made for development of PA2008 and is compliant with the Disposal Authorization Statement (DAS).
Swingle, R. F., II (2009). "Unreviewed Disposal Question Evaluation: Transcription Error in Appendix C of 2008 E-Area Low Level Waste Facility Performance Assessment." SRNL-RP-2009-00273, Rev. 0. Savannah River National Laboratory, Aiken, SC. February 6, 2009.	A transcription error was discovered in a spreadsheet used to develop Appendix C in PA2008. The error affected approximately 20 values in Appendix C, which lists anticipated SOF of limits at final closure. Appendix C does not provide inventory limits but is anticipatory in nature. Correction of the error does not lead to exceedance of the current inventory limits. None of the ST DUs currently exceed their SOFs limit of 1.0. Actual operation of the DUs in the ELLWF will continue based on inventory limits at the time of waste disposal so as to avoid exceeding PA/SA limits. Therefore, ELLWF operation is maintained within the PA and DAS.
Wilhite, E. L., Butcher, B. T., Phifer, M. A., and Reed, S. R. (2009). "Unreviewed Disposal Question Evaluation: Engineered Trench Sump Closure and Replacement." SRNL-TR-2009-00042, Rev. 0. Savannah River National Laboratory, Aiken, SC. March 11, 2009.	This UDQE evaluates the proposed actions of abandoning operation of the ET01 sump, cracking the sump bottom concrete so as to not impede flow of water through the trench, and backfilling the sump with soil. Because soil placed into the sump can only be compacted at the top of the sump (i.e., the trench floor), additional soil must be emplaced to ensure that, upon subsidence, the waste emplaced over the sump will not settle below the trench bottom. This proposed action is a change to the disposal facility analyzed in PA2008, which assumes no sump will be present after the ETs are filled with waste, the waste is above the trench bottom, and there is no connection between the two ETs. However, the proposed action does not impact the assumptions made in PA2008 because the existing sump is clean, the sump bottom concrete will be broken up so that it will not impede the flow of water, the backfill will be emplaced to ensure that subsidence will not cause waste to settle below the trench bottom, and the connecting pipe will be sealed. Therefore, this proposed action is within compliance of the DAS and will bring the ET configuration in closer alignment with the concept analyzed in PA2008.
Jordan, J. M., and Flach, G. P. (2009). "Unreviewed Disposal Question Evaluation: E-Area Low-Level Waste Facility Completion Project." SRNL-TR-2009-00207, Rev. 0. Savannah River National Laboratory, Aiken, SC. June 22, 2009.	A plume interaction study evaluated the proposed action of developing new DUs within a portion of the remaining 100 acres of the ELLWF. The study, based on the 100-meter compliance point with all DUs in use, included existing DUs as well as the potential new plots located north and west of the existing disposal facility. As a whole, the radionuclide disposal capacity available for new plot areas is limited by the existing upstream DUs. The available radionuclide source density ranges from 82% to 17% of the density for a center ST (ST01 through ST07). Plot 9 is most negatively impacted as it receives significant upstream overlap from existing DUs. Based on their proximity to the seepline, the new plot areas may contribute a significant amount of dose to the site composite analysis. In addition, the low clay content expected in the new plot areas may impact the soil’s ability to support vertical STs.
Jones, W. E., Wilhite, E. L., and Butcher, B. T. (2009). "Unreviewed Disposal Question Evaluation: Disposal of Tall Used Equipment Storage Boxes Number 5 and Number 42 in Slit Trench Number 8." SRNL-TR-2009-00236, Rev. 0. Savannah River National Laboratory, Aiken, SC. August 6, 2009.	Portions of STs that are deeper than the nominal 20-foot ST depth assumed for PA modeling will be required for a limited number (currently six) of ‘tall’ containers identified in E-Area’s Used Equipment Storage Area. This UDQE evaluates proposed actions of burying ‘tall’ Used Equipment Storage Area boxes in ST08. Box Numbers 5 and 42 are referred to as tall boxes because their height exceeds 16 feet. The currently analyzed waste zone thickness for an ST is nominally 16 feet, with a nominal trench depth of 20 feet. Box Number 5 is a vessel vent scrubber burial box while Box Number 42 is a tank in an agitator storage box. The two boxes considered in this UDQE will require trench depths of 23 ft-1 in. for Box Number 5 and 24 ft-2 in. for Box Number 42, assuming that the nominal 4 feet of clean soil is emplaced over the boxes. These containers cannot be laid on their sides during disposal due to safety issues or other considerations. Some of these boxes may require a trench depth of up to 35 feet. Tall box disposal potentially differs from the previous PA modeling approach in four respects: (1) Tall boxes comprise a thicker waste zone than analyzed in the PA (>16 feet); (2) The bottom of trench segments containing tall boxes will be closer to the water table; (3) The upper 20 feet of the UVZ in the PA models contains a greater fraction of fine-grained (silt and clay) material than the underlying LVZ, and no portion of the typical-thickness waste layer lies within the LVZ; (4) The tall boxes’ greater depth has not been evaluated for potential plume interaction effects. The proposed disposal parameters have been determined to be reasonably bounded within the existing PA modeling approach, and to not warrant additional modeling. This proposed action is considered to be within compliance of the DAS and is in alignment with the concept analyzed in PA2008.
Jones, W. E., and Phifer, M. A. (2010). "Unreviewed Disposal Question Evaluation: Installation of Additional Concrete Anchors in the Floor of LAW Vault Cell 11 to Support an Extension of the Temporary Airlock Enclosure." SRNL-TR-2010-00196, Rev. 0. Savannah River National Laboratory, Aiken, SC.	This UDQE evaluates the proposed action of installing additional concrete anchors in the floor of LAWV Cell 11 to support an extension of the temporary airlock enclosure. Approximately 55 anchor bolts are expected to be installed in the Cell 11 concrete floor to secure the airlock extension walls. The proposed activity could affect physical performance, if anchor bolt drilling compromises the physical integrity of existing floor rebar and/or concrete, and hydraulic performance, if the anchor bolt holes upon removal are not properly backfilled with a material having hydraulic conductivity properties comparable to the existing concrete. This UDQE defines specifications for the anchor hole fill material to ensure physical and hydraulic performance integrity.
Flach, G. P., and Jones, W. E. (2010). "Unreviewed Disposal Question Evaluation: Disposal of Tall Used Equipment Storage Boxes in Slit Trench Numbers 8, 9 and 10." SRNL-STI-2010-00799, Rev. 0. Savannah River National Laboratory Aiken, SC.	This UDQE evaluates proposed actions of burying several ‘tall’ Used Equipment Storage Area boxes in ST08, ST09, and ST10 as described above for SRNL-TR-2009-00236 (Jones et al., 2009). The boxes described in this UDQE range from 20 to 26 feet in height, and some contain lead which requires exterior encasement in grout to meet SCDHEC regulations. A key PA2008 assumption preserved throughout the PORFLOW analysis is that the trench is backfilled with soil that can be assigned a "Clayey" K_d as defined by (Kaplan, 2006). Historically this condition has been met in the central ST area by excavating to a depth of 20 feet or less, where the native sediments are considered "Clayey." Sediments below 20 feet are considered "Sandy" in PA2008. For this UDQE to have bearing on ST08 through ST10, E-Area Operations will need to consider local soil conditions and ensure that trenches are backfilled with "Clayey" material through some means. This proposed action is considered to be within compliance of the DAS and is in alignment with the concept analyzed in PA2008.

Table A-2 (cont'd). List of Unreviewed Disposal Question Evaluations Prepared in Support of E-Area Low-Level Waste Facility Since Issuance of 2008 Performance Assessment

Supporting Unreviewed Disposal Question Evaluations Reference in Chronological Order	Summary
Smith, F. G., III, and Swingle, R. F., II (2011). "Unreviewed Disposal Question Evaluation: Issues Associated with the Disposal of the Heavy Water Components Test Reactor." SRNL-STI-2011-00203, Rev. 0. Savannah River National Laboratory, Aiken, SC. March 29, 2011.	As part of the SA for disposal of the HWCTR vessel in ST14 (Hamm and Smith, 2010), two PA issues were identified that are resolved by this UDQE. First, this UDQE demonstrates that increasing the trench width for ST14 from the maximum of 20 feet assumed in the SA to an actual width of 23 feet will not increase radionuclide flux to the water table or total estimated SOF by more than 10%. Changes in conditions of 10% or less do not require an immediate SA and can be incorporated in the next scheduled update of the PA. Second, this UDQE demonstrates that adjusting SA time intervals to match those in PA2008, coupled with using the most conservative SA limit that covers the new time intervals, results in a negligible increase in impacts. Therefore, no new disposal limits were calculated in this UDQE, and a new SA is not required.
Smith, F. G., III, and Swingle, R. F., II (2011). "Unreviewed Disposal Question Evaluation: Center Slit Trenches One through Five Operational Covers Reanalysis." SRNL-STI-2011-00257, Rev. 0. Savannah River National Laboratory, Aiken, SC. May 19, 2011.	Accelerated placement of stormwater runoff covers over ST01 through ST05 put the cover timing outside of the range considered in the 2008 SA (Collard and Hamm, 2008) which establishes ST disposal limits. Results from a recent study (Collard et al., 2011) demonstrate that the actual cover installation in December 2010 produces acceptable ST performance. Additionally, covering ST05 separately from ST06 and ST07, which will be operationally closed at a later date, does not adversely affect performance of the operationally closed trenches.
Tempel, K. L. (2013). "Unreviewed Disposal Question Evaluation: Disposal of High Inventory Container in Slit Trench 8." SRNS-RP-2013-00196, Rev. 0. Savannah River Nuclear Solutions, Aiken, SC.	During implementation of new disposal limits for ST08 resulting from the 2012 SA (Swingle, 2012), it was discovered that one container disposed in ST08 exceeded one of the 5% SOF container inventory limits. The 5% container limits protect a key PA assumption to ensure that the waste inventory is uniformly distributed throughout each trench footprint. Because of the large size of the container and favorable disposal location within the trench, as well as the low disposed inventory and conservative geographical distribution of the inventory within the ST08 footprint, it was concluded that there would be no adverse impact on PA2008.
Hamm, L. L., Smith, F. G., Flach, G. P., Hiergesell, R. A., and Butcher, B. T. (2013). "Unreviewed Disposal Question Evaluation: Waste Disposal in Engineered Trench #3." SRNL-STI-2013-00393, Rev. 0. Savannah River National Laboratory, Aiken, SC.	ET03 will be placed in the location previously designated for ST12 in PA2008. This UDQE evaluates whether ST12 disposal limits can be employed as surrogate limits for ET03 operations. The UDQE concludes that use of ST12 limits as surrogates for ET03 will provide reasonable assurance that DOE M 435.1-1 POs and measures (U.S. DOE, 2011c) will be protected and, therefore, new ET03 inventory limits as determined by an SA are not required. Based on this UDQE, ET03 disposal will consist of generic waste and crushable waste containers (i.e., no SWFs and/or non-crushable waste containers are allowed). This UDQE was revised in 2017 to include ET04 (Butcher et al., 2017).
Flach, G. P., Smith, F. G., Hamm, L. L., and Butcher, B. T. (2014). "Unreviewed Disposal Question Evaluation: Impact of New Information since 2008 PA on Current Low-Level Solid Waste Operations." SRNL-STI-2013-00011, Rev. 1. Savannah River National Laboratory, Aiken, SC.	This UDQE assesses the ability to meet POs by estimating the influence of new information items on a recent SOF snapshot for each currently active ELLWF DU. A final SOF, as impacted by this new information, is projected based on the assumptions that the current disposal limits, WITS administrative controls, and waste stream composition remain unchanged through DU operational closure in 2025. Revision 1 of this UDQE addresses: new K_d values for iodine, radium, and uranium; elimination of cellulose degradation product (CDP) factors; updated radionuclide data; changes in transport behavior of mobile radionuclides; potential delay in interim closure beyond 2025; CIG plume interaction correction. Consideration of new information relative to the PA2008 baseline generally indicates greater confidence that PA POs will be met than indicated by current SOF metrics.
Butcher, B. T., Hamm, L. L., and Flach, G. P. (2017). "Unreviewed Disposal Question Evaluation: Waste Disposal in Engineered Trenches 3 and 4." SRNL-STI-2013-00393, Rev. 1. Savannah River National Laboratory, Aiken, SC.	Rev. 0 (Hamm et al., 2013) addressed the proposal to place ET03 in the footprint designated for ST12 and operate using ST12 disposal limits. Similarly, Rev. 1 evaluates whether ET04 can be located in and operated to ST13 disposal limits. Both evaluations conclude that the proposed operations result in an acceptably small risk of exceeding a SOF of 1.0 and approve these actions from a PA perspective. Because ET03 will be placed in the location previously designated for ST12, SWM requested that the SRNL determine if the ST12 limits could be employed as surrogate disposal limits for ET03 operations. SRNL documented in this UDQE that the use of ST12 limits as surrogates for the new ET03 DU will provide reasonable assurance that U.S. DOE 435.1 POs and measures will be protected. Therefore, new ET03 inventory limits as determined by an SA are not required.
Germain, S. H. (2018). "Performance Assessment UDQ Process and Implementation of Interim Measures for Change in GSA Groundwater Flow Model." SRNS-N3000-2018-00017. Savannah River Nuclear Solutions, Aiken, SC. August 1, 2018.	The PORFLOW version used in PA2008 showed flow fields generally parallel to the length of the DUs in the southeast end, which minimized overlap of plumes emanating from adjacent DU. In contrast, the GSA_2018 model indicates flow fields near the southeast end are more perpendicular to the length of the DUs, causing plumes from adjacent DUs to overlap significantly. This degree of plume overlap was not accounted for in development of the ELLWF disposal limits. A UDQ Screen concluded that a UDQE is needed to determine if current disposal limits, given the new flow fields, are still protective of DOE M 435.1-1 POs (U.S. DOE, 2011c). To minimize risk to the operating facility in meeting POs while the UDQE is developed, interim measures were identified for impacted DUs. Impacted DUs that are not operational (i.e., ST15 through ST21) will not be opened. For operational units (i.e., ST14 and ET02), the interim measures include reducing both the beta-gamma (BG2) and all-pathways (AP2) SOFs as well as reducing the allowable volume of "non-crushable" containers.
Simmons, J. (2020). "UDQE to Determine Significance of TPBAR Disposal Container #4 Weld Leak Rate." SRNS-TR-2020-00005, Rev. 0. Savannah River Nuclear Solutions, Aiken, SC. August 2020.	This UDQE evaluates the disposal impact of TPBAR Disposal Container #4, which was initially found to have an out-of-spec weld leak rate. This analysis determines total tritium release from the disposal container due to both a cask leak (bounding value of 4.9E-04 std cc air per sec was used for this analysis) and tritium diffusion through the disposal container walls, lid, and welds; all tritium release values in PA2008 are via diffusion. PA2008 did not examine tritium release from disposal containers due to leaks. The UDQE calculation showed that TPBAR Disposal Container #4 with a cask leak rate of 4.9E-04 std cc air per sec will release approximately 4.6% additional tritium over the course of the analyzed life. Relative to all 17 TPBAR disposal containers analyzed, this will result in an increase of 0.28% tritium released over the course of the analyzed lives of all containers. This increase in tritium release is not seen as significant relative to what was previously analyzed because of the conservatism within PA2008. It should be noted that a subsequent leak test was performed on TPBAR Disposal Container #4 after it was received by the Tritium Extraction Facility and repairs to discovered weld defects were completed. The container leak rate measured in this on-site leak test was significantly less than what was measured at the manufacturer's facility. Therefore, the tritium release calculation performed within this UDQE is bounding to TPBAR Disposal Container #4.

Table A-3. List of Other Analyses and Assessments Prepared in Support of E-Area Low-Level Waste Facility Since Issuance of 2008 Performance Assessment

Supporting Analysis or Assessment Reference in Chronological Order	Summary
Smith, F. G., III (2010). "GoldSim Analysis of Slit Trench 1." SRNL-L5200-2009-00085, Rev. 1. Savannah River National Laboratory, Aiken, SC.	This memorandum describes the approach taken and results obtained from an analysis of ST01 performed using a modified version of the recently developed GoldSim® CA model. Assuming a tritium source of 8.4 mCi in 96 ft^3, the GoldSim® model is able to reproduce data from lysimeter VL-26 data at the -30 ft level. The 8.4 mCi source is within the range of tritium found in ST disposals in the vicinity of VL-26. The model predicts a maximum GW tritium concentration at 100 meters that is about 1% of the MCL. The model is unable to reproduce lysimeter data at -40 ft. The most likely explanation for this is that flow has a horizontal component that is preferentially moving the plume across the -30 ft level.
Estochen, E. G. (2010). "ETF Carbon Vessel Post Burial Failure Assessment." M-CLC-E-00046, Rev. 1. Savannah River National Laboratory, Aiken, SC. March 2010.	The purpose of this calculation is to estimate time to failure for ETF Carbon Vessels buried in STs when subjected to degradation by corrosion over a control period of 130 years and beyond. Based on the use of bounding soil conditions, and the estimated upper-bound and lower-bound corrosion rates (0.001 in yr^{-1} upper bound based on pitting, and 0.00004 in yr^{-1} lower bound based on general corrosion), the ETF Carbon vessels will not collapse due to dynamic compaction of the entire overlying soil column and addition of a final soil cap at final closure. Based on the corrosion rates utilized, the vessels will become hydraulically active 133 years after burial. Assuming final closure that includes dynamic compaction and placement of a final cap after 130 years of vessel burial, it is estimated that the vessels will corrode to a condition conducive to wall buckling and collapse in the burial time range of 131-3,282 years. Failure is likely to result in a subsidence of less than 4 feet due to the collapse limitations imposed by the vessel contents and geometry. Dynamic compaction is expected to result in a crushed vessel 113 years (upper bound corrosion rate) or 2,833 years (lower bound corrosion rate) after burial.
Estochen, E. G. (2010). "Heavy Water Component Test Reactor (HWCTR) Burial Failure Analysis." M-CLC-E-00048, Rev. 0. Savannah River National Laboratory, Aiken, SC. July 2010.	The purpose of this calculation is to estimate time to content release, due to fluid exchange with the surrounding soil (hydraulic activity), and soil-induced crush failure for HWCTR after burial in an ST. It will take 28 years for the container to become hydraulically active based on general corrosion of opening cover welds. At the conclusion of 28 years, significant leak area will exist proximate to several HWCTR openings, causing hydraulic exchange of material with the surrounding soil. HWCTR is not crushable by dynamic compaction immediately after burial. Based on general corrosion alone, it will take >886 years for HWCTR to become unstable, buckle, and collapse due to soil pressure. Pitting corrosion for the thick-walled HWCTR is not a significant factor in the corrosion evaluation based on the stalling of pit depth advancement that occurs over time. Therefore, use of a conservative general corrosion rate in this analysis is bounding for the long-term behavior of HWCTR.
Phifer, M. A. (2011). "Engineered Trench #3 Location Options Evaluation: Intact and Subsided Infiltration Estimates." SRNL-STI-2011-00732, Rev. 0. Savannah River National Laboratory, Aiken, SC. December 2011.	In association with the evaluation of four potential ET03 locations under consideration (Collard and Hamm, 2012), flow and transport modeling should use the following for ET03 infiltration estimates: (1) intact ET03 closure cap infiltration that accounts for closure cap degradation over time without subsidence; (2) subsided ET03 closure cap infiltration that accounts for edge-of-trench subsidence, without any upslope subsidence, and for closure cap degradation over time.
Collard, L. B., and Hamm, L. L. (2012). "Alternatives Analysis for Selecting ET #3 Site." SRNL-STI-2012-00047, Rev. 0. Savannah River National Laboratory, Aiken, SC. February 2012.	Based on forecasts from waste generators, the last ET in operation (ET02) is anticipated to close in FY14, requiring development of a new ET. This report reviews four disposal options for ET03 and determines which option will provide the most favorable PA disposal limits for the ELLWF. The four options are: (1) disposal at grade on TRU Pads 7-13 where soil would be mounded over waste packages; (2) excavation at a slightly modified ST13 location near the Used Equipment Storage Area; (3) excavation at a modified ST12 location near the NR26E pad; and (4) excavation east of TRU Pad #26 that replaces northeast portions of four STs in the eastern sector. The evaluation concludes that Options 2 and 3 are quantitatively and qualitatively the most desirable and are equally suitable locations.
Swingle, R. F. (2012). "Revision of the ELLWF Disposal Limits Database Adding Reactor Heat Exchanger Limits (Rev. 2012-1)." SRNL-L3200-2012-00020. Savannah River National Laboratory, Aiken, SC.	This revision to the ELLWF Disposal Limits Database adds SWF limits for the disposal of reactor process heat exchangers in the West STs. The database provides a single up-to-date location containing all of the currently valid ELLWF DU inventory limits and will is updated as revisions to ELLWF inventory limits are made.
Sink, D. F. (2014). "Evaluation of Suitable Alternatives for the Current Interim Stormwater Covers Over Slit Trenches." SRNS-RP-2014-01201, Rev. 0. Savannah River Nuclear Solutions, Aiken, SC.	Solid Waste assembled a review team to assess 11 different cover options, including the current interim stormwater covers over STs, to find the most suitable alternatives for use in interim covers. The evaluation considered infiltration rates, cost, subsidence repair, severe weather impacts, reapplication needs, other maintenance requirements, and whether the regulators have accepted this application before. The top three cover options were: (1) concrete cloth; (2) asphalt; (3) spray-on asphalt.
Hiergesell, R. A., and Taylor, G. A. (2015). "General Separations Areas (GSA) Groundwater Level Measurement Analysis." SRNL-STI-2015-00034, Rev. 0. Savannah River National Laboratory, Aiken, SC.	The purpose of the described work is to provide a means of evaluating the existing database of water level measurements obtained from all historical and existing monitoring wells to determine the best target well measurements to utilize in recalibration of the existing GSA regional GW flow model (Flach, 2004). An automated, spreadsheet-based, tool was developed to perform the necessary processing of 1,172 current and historical wells (and associated 77,000+ individual measurements of depth to water) present or present at one time within the GSA model footprint. Well construction information for each of the 1,172 wells was also evaluated to make a new determination of which hydrostratigraphic unit is in hydraulic communication with each well.
Hang, T., and Flach, G. P. (2016). "E-Area Low-Level Waste Facility Cover Overhang Analysis." SRNL-STI-2016-00251, Rev. 0. Savannah River National Laboratory, Aiken, SC.	PORFLOW analyses were performed with a focus on STs and ETs to evaluate the minimum required cover overhang size that will prevent any adverse impact on ELLWF overall performance. Cover overhang is defined as the lateral distance that a low-infiltration cover extends beyond the edge of the trench unit in any direction. Analyses were carried out for H-3 (short half-life), I-129 (very long half-life), and Sr-90 (moderate half-life with intermediate K_d) at different overhang sizes (5 ft, 10 ft, 20 ft, 50 ft, and infinite), cover timing (0 yr, 10 yr, 20 yr, and 30 yr), and scenarios (intact and a limited dynamic compaction case). H-3, I-129 and Sr-90 are representative of radionuclides that typically drive the SOF for a trench DU. The following measures are recommended: (1) in general, the minimum cover overhang size to provide low infiltration is 40 feet; (2) on the upgradient side of the ELLWF, the cover overhang can be less than 40 feet because a drainage system and adjoining cover system already exist to divert infiltration away from the waste zone.

Table A-3 (cont'd). List of Other Analyses and Assessments Prepared in Support of E-Area Low-Level Waste Facility Since Issuance of 2008 Performance Assessment

Supporting Analysis or Assessment Reference in Chronological Order	Summary
Shipmon, J. C., and Dyer, J. A. (2017). "Analysis of Factors that Influence Infiltration Rates using the HELP Model." SRNL-STI-2017-00506, Rev. 0. Savannah River National Laboratory, Aiken, SC.	The HELP model is used in conjunction with PORFLOW GW flow simulation software to make long-term predictions of the radionuclide fate and transport. This project focused on conducting a sensitivity analysis of infiltration through the proposed ELLWF final closure cap to identify the cap design and material property parameters that most impact infiltration rates through the proposed closure cap for a 10,000-year simulation period. The results of the sensitivity analysis indicate that saturated hydraulic conductivity (K_{sat}) for select cap layers, precipitation rate, surface vegetation type, and geomembrane layer defect density are dominant factors limiting infiltration rate. Interestingly, calculated infiltration rates are substantially influenced by changes in the saturated hydraulic conductivity of the Upper Foundation and Lateral Drainage layers. This work and its results provide a framework for quantifying uncertainty in the radionuclide transport and dose models for the planned PA2022.
Skibo, A. Z. (2018). "SRNL Bamboo (Phyllostachys Species) Planting Site Assessment, Savannah River Site." SRNL-STI-2017-00638, Rev. 0. Savannah River National Laboratory, Aiken, SC.	The use of an invasive species such as bamboo for long-term planting over closed radioactive waste disposal sites has been studied extensively at SRS. These heavily rhizomatous, perennial species exhibit many characteristics deemed useful for the purpose: low to no maintenance requirements; high evapotranspiration rate; tolerance of a wide range of environmental conditions; tolerance of poor soil nutrition and characteristics; aggressive growth and prodigious litter cover to preclude native woody species recolonization; and the ability to maintain this cover for many decades following establishment. This site reassessment conducted 8 years after the previous evaluation noted little difference from previously collected data. Overall plant vigor, population density, and leaf area cover was very similar to that recorded in 2009. The establishment of Loblolly and Longleaf Pines within the plantation was noted and data collected suggests this occurred within the first decade following site establishment. Analysis of environmental conditions suggests that *Phyllostachys bissettii* and *P. rubromarginata* are at least as tolerant of drought conditions as Loblolly Pine and as such, water use should not be of primary concern for future evaluations. Based on this and previous assessments of the performance of the site's bamboo test plots over 26 years, and conservative projections of long term (1000-year) performance, bamboo is considered a viable final vegetative cover over SRS closure caps. Recommendations are provided on timing and rate of pine tree encroachment/succession into an SRS bamboo cover stand and other pertinent considerations over the post-closure period for use in estimating infiltration in PA models.

Table A-4. List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
A. General							
A.1	The inventory limits developed for each radionuclide (including those for SWFs) are applicable upon approval of this PA. Therefore, all inventory limits currently in use (limits from previous PAs, SAs, UDQEs, and/or other sources) are superseded by this PA upon execution of the Implementation Plan.	✓	✓	✓	✓	✓	✓
A.2	The trigger values developed for radionuclides (not currently within the WITS) are applicable upon approval of this PA. Therefore, all trigger values currently in use (trigger values from previous PAs, SAs, UDQEs, and/or other sources) are superseded by this PA upon execution of the Implementation Plan.	✓	✓	✓	✓	✓	✓
A.3	Only contaminants and/or waste forms that are screened out or explicitly analyzed as described in this PA are candidates for disposal (Section 2.3).	✓	✓	✓	✓	✓	✓
A.4	The ELLWF opened on September 28, 1994 (Section 2.2.1).	✓	✓	✓	✓	✓	
A.5	EM operations conclude in Year 2065 in alignment with the SRS Nuclear Materials Management Plan FY2016-2030 (SRS, 2016).	✓	✓	✓	✓	✓	✓
A.6	A 71-year operational period begins September 28, 1994, followed by operational closure on September 30, 2065, followed by a 100-year IC period (Section 1.5).	✓	✓	✓	✓	✓	
A.7	The relative time of the operational period from the start of ELLWF operations is Years 0 – 71 (Section 1.5).	✓	✓	✓	✓	✓	
A.8	The relative time of the IC period from the start of ELLWF operations is Years 71 – 171, specifically, calendar years 2065 through 2165 (Section 1.5).	✓	✓	✓	✓	✓	
A.9	The period of performance is Years 171 – 1,171 after the start of ELLWF operations (Section 1.5).	✓	✓	✓	✓	✓	
A.10	Existing and future DUs are situated according to Figure 1-2 [footprints by Hamm (2019)].	✓	✓	✓	✓	✓	✓
A.11	No future CIG trench segments are expected (Section 1.4.2). However, the use of grout material as an engineered barrier is not being prohibited (e.g., use in encapsulating lead materials).	✓					
A.12	ST and ET operations begin in December 1995 and February 2001, respectively (Table 4-6).	✓	✓				
A.13	LAWV operations begin September 28,1994, when the ELLWF is opened (Table 4-49).			✓			
A.14	ILV operations begin September 28, 1995 (Table 4-59).				✓		
A.15	All dose estimates in this PA assume that each DU reaches its activity capacity and is not volume limited (Section 8.7).	✓	✓	✓	✓	✓	
A.16	Each DU is filled to its activity capacity when calculating GW and atmospheric plume overlap and dose impact effects for deterministic and stochastic simulations (Section 8.7).	✓	✓	✓	✓	✓	
A.17	Calculated total SOFs for each DU use the closure inventory estimates provided in Appendix H. Changes to these estimates should never result in a total SOF exceeding a value of 1.0 for any DU.	✓	✓	✓	✓	✓	✓
A.18	Mechanical dispersion is not explicitly accounted for in all PORFLOW VZ transport models, while PORFLOW aquifer models employ a four-parameter dispersion model [Hamm and Aleman (2000) and Section 3.5.3.1].	✓	✓	✓	✓	✓	
B. Operational Closure							
B.1	Minimum 20-inch-thick, reinforced-concrete mats are placed over the CIG-8 and CIG-9 trench segments to provide structural support for a period lasting a minimum of 300 years. No reinforced-concrete mats are required for CIG-1 through CIG-7 [Peregoy (2006a) and Section 8.3.3.1.2].	✓					
B.2	Stormwater runoff covers are installed at operational closure to optimize stormwater runoff and limit infiltration into the underlying waste zone for STs and the nine existing CIG trench segments (Section 2.2.1.1).	✓					✓
B.3	Operational soil covers are used for operational closure of ETs to optimize stormwater runoff and minimize infiltration into the underlying waste zone (Section 2.2.1.1).		✓				✓
B.4	The operational norm for all trenches is a 4-foot-thick "clean backfill" without intrusions; no foreign material is within the upper 2 feet of the 4-foot-thick, clean backfill. Uncontaminated metals (e.g., carbon steel, stainless steel, and aluminum) can intrude into the lower 2 feet of the 4-foot-thick, clean backfill if it is determined (on a case-by-case basis) that rectifying the condition is not feasible (Phifer, 2003b). (This assumption does not address the intrusion of any types of materials other than metals.)	✓	✓				✓
B.5	Operational soil covers are placed over all ETs that are filled by September 2040 (Table 4-6).		✓				✓
B.6	Operational stormwater runoff covers extend 10 feet past the edge of a ST's waste zone footprint in all cases (Section 2.2.1.1).	✓					✓
B.7	Operational stormwater runoff covers (for STs and CIG trench segments) and operational soil covers (for ETs) are maintained to ensure positive drainage away from the trenches (Section 2.2.1.1).	✓	✓				✓
B.8	For operational stormwater runoff covers, the drainage systems that are employed to divert runoff away from the waste zone footprint areas are maintained (Section 2.2.1.1).	✓					✓
B.9	Following closure, the LAWV interior collection trench and exterior sump are filled with grout. All exterior vault openings (including those between modules) are sealed with reinforced concrete equivalent to the concrete used for the vault floor, walls, and roof. The reinforcing steel is tied into the reinforcing steel of the vault itself, forming a unified structure with continuous walls (Section 2.2.5.1).			✓			✓
B.10	The headspace in each ILV cell is filled with grout, and a reinforced-concrete roof slab and waterproof membrane are installed (Section 2.2.1.1).				✓		✓
B.11	Soil (instead of CLSM) is mounded over all containers on NR26E; CLSM is not considered because slightly acidic soil moisture can impact carbon steel corrosion (Table 2-21). (Note: In 2005, this process was implemented at NR07E.)					✓	✓
B.12	The average subsidence potential for an ET following operational closure is estimated to be 13.5 feet based on a stack of four B-25 boxes containing low-density waste [based on Section 7.2 by Nichols and Butcher (2020) and Section 1.12.7].		✓				
B.13	The average subsidence potential for a ST following operational closure is estimated to be 4.9 feet based on a mixture of 33% containerized waste and 67% bulk waste [based on Section 7.1 by Nichols and Butcher (2020) and Section 1.12.7].	✓					
B.14	Operational stormwater runoff covers are placed over STs no later than four years after the date of last waste placement in the projected timeline (Section 4.4.4).	✓					✓
B.15	Operational stormwater runoff covers were placed over CIG-1 through CIG-8 on April 1, 2006 [Year 12] (Section 4.2.1.2).	✓					
B.16	An operational stormwater runoff cover was placed over CIG-9 three months after placement of the final waste package (Section 4.2.1.2).	✓					

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
C. Interim Closure							
C.1	For STs and ETs, interim closure is implemented at the end of the operational period (September 2065; for DUs filled by September 2040, interim closure begins then) and extends through the 100-year IC period to final closure in September 2165 (Table 2-14).	✓	✓				✓
C.2	Interim covers are actively maintained during the 100-year IC period (Sections 1.5 and 2.2.1.2).	✓	✓				✓
C.3	Interim closure is implemented as described in Section 2.2.1.2 (Phifer et al., 2009).	✓	✓				✓
C.4	A complete interim cover is placed over all STs and ETs by September 30, 2065 (Section 2.2.1.2).	✓	✓				✓
C.5	For trenches, the interim cover overhang extends 10 feet past each DU's footprint edges that are not part of the contiguous cover (Section 2.2.1.2).	✓	✓				✓
C.6	After installation of the interim cover by 2065, a 600-foot-wide, treeless, Bahia grass buffer zone is actively maintained on all sides of the interim cover (Section 3.4.1.3).	✓	✓				✓
C.7	Stormwater runoff drainage systems and interim runoff covers are maintained and subsidence-induced damage to the covers is appropriately repaired (Section 2.2.1.2).	✓	✓				✓
C.8	Other than monitoring and maintenance activities, no interim closure actions are planned beyond operational closure during the 100-year IC period for the LAWV, ILV, and NRCDAs (Sections 2.2.5, 2.2.6, and 2.2.7, respectively,).			✓	✓	✓	
D. Final Closure							
D.1	Final closure of all DUs in the ELLWF takes place by September 30, 2165, at the end of the 100-year IC period when the final closure cap is installed over all DUs [(SRS, 2016) and Section 2.2.2].	✓	✓	✓	✓	✓	✓
D.2	The hydraulic performance of the closure cap begins to degrade immediately upon installation because of long-term natural degradation mechanisms, resulting in increased infiltration through the cap over time [(Dyer, 2019b) and Section 1.4.9].	✓	✓	✓	✓	✓	
D.3	The implemented stabilization measures sufficiently consolidate the underlying waste layer and eliminate subsidence except where "non-crushable" containers are located (Table 2-16).	✓	✓	✓	✓	✓	✓
D.4	Dynamic compaction of STs and ETs is performed at the end of the 100-year IC period except for SWF areas (e.g., areas containing M-Area glass and ETF Carbon Columns) that have been specifically designated not to undergo active waste stabilization measures (Sections 2.2.3.4 and 2.2.4.4).	✓	✓				✓
D.5	Dynamic compaction of crushable containerized waste and bulk waste results in average, collapsed, waste-zone heights after dynamic compaction of 11.1 feet for STs and 2.5 feet for ETs (Sections 2.2.3.4 and 2.2.4.4).	✓	✓				
D.6	Subsidence occurs at the end of the IC period for CIG trench segments without a reinforced-concrete mat that have subsidence potential (CIG-7 through CIG-7) (Danielson, 2020c).	✓					
D.7	Subsidence occurs 200 years after the end of the IC period for CIG trench segments with a reinforced-concrete mat (CIG-8 and CIG-9) (Danielson, 2020c; Peregoy, 2006a).	✓					
D.8	The final closure cap overhang extends 40 feet past edges that are not part of the contiguous cover (Section 2.2.2.6).	✓	✓	✓	✓	✓	✓
D.9	Except for the CIG SWF, subsided regions fall along the long slope of the final closure cap at three locations: (1) corner of the trench footprint, (2) with an edge aligned at the midpoint of the long slope, and (3) with an edge aligned at the cap's crest (Danielson, 2019a).	✓	✓				
D.10	Percent subsidence of the final closure cap is determined by the areal footprint of existing non-crushable containers in closed DUs and capped at 2% for operational and future units. Percent subsidence is computed based on each DU's actual overall footprint size (Dyer, 2019b; Table 2-3).	✓	✓				
D.11	At the end of IC in calendar year 2165, mature pine trees exist at the outer edge of the 600-foot buffer zone; no pine trees are established within the ELLWF active maintenance area (i.e., the nearest mature pine tree stand is at least 600 feet from the closure cap when the cap is installed in calendar year 2165) (Section 3.4.1.3).	✓	✓	✓	✓	✓	✓
D.12	Following installation of the final closure cap, no closure cap maintenance other than that required to establish the vegetative (Bahia grass) cover is performed (Section 1.12.5).	✓	✓	✓	✓	✓	✓
D.13	Waste zone subsidence as a closure-cap degradation mechanism is central to the conceptual designs of the infiltration, flow, and transport models (both deterministic and stochastic) for all ELLWF DUs except the NRCDAs. For STs, ETs, and the CIG trench segments, waste zone subsidence impacts DU performance during the 1,000-year compliance period. For the LAWV and ILV, subsidence of the closure cap due to structural collapse of the concrete vault covers occurs during the extended 10,000-year simulation period (Table 3-1).	✓	✓	✓	✓		
D.14	No active facility maintenance is performed during the 1,000-year post-closure compliance period (Section 1.12.5).	✓	✓	✓	✓	✓	
D.15	Limited erosion occurs over the 10,000-year period considered in this PA, but it does not significantly impact infiltration estimates (Section 3.4.1.4.1).	✓	✓	✓	✓	✓	
D.16	Acute erosion of the closure cap (caused by deep animal burrowing or a PMP event that initiates gully formation) is localized such that the overall impact to closure cap performance is minimal (Section 3.4.1.4.1).	✓	✓	✓	✓	✓	
D.17	Pine tree roots freely penetrate the erosion barrier stone (upper bounding assumption) (Section 3.4.1.5.2).	✓	✓	✓	✓	✓	
D.18	The erosion barrier acts as a barrier to burrowing animals and feral hogs and includes selecting material to fill the void space of the erosion barrier stone (Section 3.4.1.5.2).	✓	✓	✓	✓	✓	
D.19	The lateral drainage layer progressively silts-in with colloidal clay that migrates from the overlying upper backfill layer, thereby steadily reducing its saturated hydraulic conductivity over time (Section 3.4.1.6.1).	✓	✓	✓	✓	✓	
D.20	Antioxidant depletion of the HDPE geomembrane occurs via oxidation of the antioxidants and diffusion out of the polymer (Table 3-3).	✓	✓	✓	✓	✓	
D.21	Thermal oxidation of the geomembrane occurs after antioxidant depletion and in conjunction with tensile stress cracking, which causes degradation of the geomembrane (Table 3-3).	✓	✓	✓	✓	✓	
D.22	Roots can penetrate the geomembrane only at locations where holes have already formed due to HDPE degradation (Section 3.4.1.7.6).	✓	✓	✓	✓	✓	
D.23	The GCL is covered by the HDPE layer; roots cannot penetrate the GCL until the HDPE layer develops holes and then the roots grow through them (Section 3.4.1.8.6).	✓	✓	✓	✓	✓	
D.24	In the infiltration model, sodium bentonite is converted to calcium and magnesium bentonite after only 100 years, resulting in an increase in the saturated hydraulic conductivity of the GCL from 5.0E-09 cm s^{-1} for the first 100 years to 5.0E-08 cm s^{-1} thereafter (Table 3-3).	✓	✓	✓	✓	✓	
D.25	Final closure is implemented as described in Section 2.2.1.3.	✓	✓	✓	✓	✓	✓
D.26	After closure, up to 7.2 feet of headspace void remains in the LAWV between the top of the waste zone and the base of the roof (Section 2.2.5.2).			✓			
D.27	Dynamic compaction is not performed over the SWF HWCTR in ST14 (Hamm and Smith, 2010).	✓					✓
D.28	Dynamic compaction is not performed over the NRCDAs (NR07E and NR26E) (Section 2.2.7).					✓	✓

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
E. Waste Form, Waste Zone, Waste Inventory and Volume, and Waste Placement							
E.1	The layout of the STs and ETs is such that waste is disposed in approximately 64% and 100%, respectively, of the trench DU boundary (Hamm, 2022).	✓	✓				✓
E.2	The selected DU timelines place 100% of the inventory in each DU (uniformly distributed in the waste zone unless otherwise specified) at the time of burial of the first package. All future STs and ETs are assumed to open on September 30, 2021 (Section 1.5).	✓	✓	✓	✓	✓	
E.3	The IHI scenario considers the time of burial of the first and last package in arriving at worst case soil concentrations (Section 7.2).	✓	✓	✓	✓	✓	
E.4	The true inventory of radionuclides in waste containers characterized by the dose-to-curie method is approximately 50% of the reported inventory (Section 2.3.5).	✓	✓	✓	✓	✓	
E.5	When there is no identifiable bias in the reported inventory values, the true inventory equals the reported inventory. When there is identifiable and quantifiable bias, the true inventory is equal to the reported inventory × bias factor (e.g., the dose-to-curie method) (Section 1.12.6). When there is identifiable but not quantifiable bias, the true inventory is equal to 90% of the reported inventory (Section 2.3.5).	✓	✓	✓	✓	✓	
E.6	The reported inventory of an isotope is the product of the measured activity of each waste cut or container and the fraction of activity associated with that isotope in the waste stream of that waste cut or container. The uncertainties in the measurement and characterization fraction are independent, and the errors are random and normally distributed (assumed so these values can be added in quadrature) (Section 1.12.6).	✓	✓	✓	✓	✓	
E.7	Uncertainties in individual reported waste inventories are independent and random (assumed so the inventories may be added in quadrature) (Section 1.12.6).	✓	✓	✓	✓	✓	
E.8	The inventory uncertainty at closure is the same uncertainty as at the present time (Section 1.12.6).	✓	✓	✓	✓	✓	
E.9	Default measurement uncertainties are assigned to all waste packages; analyzed waste package values override these default values (Sections 2.3.5.4 and 2.3.5.7) [Sections 4.0 and 10.4 by Taylor and Whiteside (2022)].	✓	✓	✓	✓	✓	
E.10	Default characterization uncertainties are assigned to all waste streams; analyzed waste stream values override these default values (Sections 2.3.5.4 and 2.3.5.8) [Sections 3.2 and 10.4 by Taylor and Whiteside (2022)].	✓	✓	✓	✓	✓	
E.11	A default bias factor is assigned to all calculation methods. The RAD method has either a 100% bias factor (because it is an underlying DTC measurement) or a 0% bias factor (because it is an STC measurement). The default bias for this method is randomly selected using a weighting factor based on the distribution of DTC and STC measurements in the CWTS. If possible, this default bias is overridden when a waste package has been analyzed and an actual bias determined (Section 2.3.5.5).	✓	✓	✓	✓	✓	
E.12	In the ST, ET, ILV, and NRCDA VZ models, simple SWF inventories are uniformly distributed throughout the waste zone (e.g., boxed waste for ETs, hybrid waste for STs, and casts for NRCDAs) [Sections 5.1.2, 5.3.1.3, and 5.4.1.2].	✓	✓		✓	✓	
E.13	In the aquifer model, SWFs in trenches with known disposal locations are placed only at aquifer source nodes corresponding to the disposal location in the DU footprint (Danielson, 2021).	✓	✓				
E.14	In the aquifer model, SWFs in trenches with no known disposal location (or future disposals) are distributed uniformly across the aquifer source nodes (Danielson, 2021).	✓	✓				
E.15	Generic waste form inventories for LAWV and ILV are considered to be uniformly distributed throughout the waste zone (Section 1.12.8).			✓	✓		
E.16	To calculate air and radon pathways release, waste is assumed to be spatially uniform throughout the DUs (Section 5.1.5 for STs, ETs, and CIG trench segments; Section 5.2.3 for LAWV; Section 5.3.3 for ILV; and Section 5.4.3 for NRCDAs).	✓	✓	✓	✓	✓	
E.17	Placement of most trench SWF inventory occurs on the date when each trench unit is first opened to waste, which is consistent with the modeling assumption for generic waste (Table 4-6). Placement of future SWF inventory targeted for disposal in future trenches is September 30, 2021 (Section 4.2).	✓	✓				
E.18	Placement of SWF inventory for CIG trench segments, HWCTR, HXs, and 232-F concrete rubble was targeted to specific locations within the waste zones (Section 4.2 and 4.3).	✓					
E.19	Placement of SWF inventory for tall boxes is limited to ST08, ST09, and ST10 where the disposal regions within their waste zones are limited to the southern 220, 220, and 180 feet, respectively (Section 4.2.5).	✓					✓
E.20	The CIG trench segments degrade from a hydraulically intact CIG SWF to a degraded SWF at Year 40, at which time the hydraulic conductivity increases by nine orders of magnitude. At relative Year 371 (i.e., 200 years after the end of the IC period), the CIG SWF is considered fully degraded (Section 4.2.1.3).	✓					
E.21	There are two general subcategories of SWFs for specific ST and ET DUs where credit is taken for the waste form or disposal container: (1) those that rely on sorption properties alone (e.g., ion exchange resins) to control contaminant release; (2) those that rely on the hydraulic integrity of the container, other properties of the waste form, or a combination of both to control release (Table 3-1, Sections 4.2 and 4.3).	✓	✓				
E.22	Dynamic compaction is performed in all STs and ETs on or before September 30, 2165 (except for those SWFs to be excluded from compaction), and all impacted waste is transferred to the dynamically compacted waste zone, accompanied by changes in hydraulic properties (Section 4.4.8). Waste collapses into the lower 11.1 feet of STs (Section 4.1.3.4) and lower 2.5 feet of ETs (Section 4.2.5).	✓	✓				✓
E.23	Upon subsidence, all CIG SWF inventory is transferred to the lower half of the waste zone (Section 4.2.1.4.2).	✓					
E.24	Clayey soil K_d values apply within the waste zone of the LAWV while the vault is intact (Section 4.5.3.8.1).			✓			
E.25	Oxidizing cementitious K_d values apply within the waste zone of the ILV while the vault is intact (Section 4.6.3.8.1).				✓		
E.26	ILV SWFs include K- and L-Basin ion exchange resins (for retaining C-14, I-129, and Tc-99), ETF activated carbon, and tritium-producing burnable absorber rods (TPBAR) waste (Section 1.12.8).				✓		
E.27	The projected waste inventory for the NRCDAs is based on projections made by the U.S. Navy (Aleman and Hamm, 2021).					✓	
E.28	NR components consist of a variety of waste types including core barrels, thermal shields, shear blocks, adapter flanges, closure heads, cover plates, pumps, and other similar equipment from the Navy (Section 2.2.7.2).					✓	
E.29	There are two NRCDA waste forms: a generic waste form for bolted containers and a SWF for welded steel casks; the overwhelming majority of activity resides within casks (Section 5.4.1.3).					✓	
E.30	The radionuclide inventories for both types of NR components (surface- or crud-contaminated components and activated-metal components) are combined based on corresponding inventory ratios (Section 4.7.8.5).					✓	
E.31	The entire waste inventory is placed in NRCDAs at the time of first burial (Section 4.7.8.5.1).					✓	
E.32	NR waste burial is immediately under a soil cover, which ignores the open-air period (Wohlwend and Butcher, 2018). This assumption is pessimistically biased because carbon steel corrosion rates in air are at or below the low end of corrosion rates in soil for atmospheric conditions representative of the SRS.					✓	
E.33	Large quantities of activation products are associated with the metal matrix of the welded-cask SWFs. Significantly lower quantities of radioactive contaminants are present in corrosion products of the bolted-container generic waste forms (Section 5.4.3).					✓	

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
E. Waste Form, Waste Zone, Waste Inventory and Volume, and Waste Placement							
E.34	A non-crushable container is defined (identified) as a container with significant void space placed in a ST or ET that is not deemed compactable when dynamic compaction is applied at the end of the 100-year IC period (Section 4.1.1.2).	✓	✓				✓
E.35	Waste forms are primarily crushable steel containers; non-crushable content is not to exceed no more than 2% of a ST or ET unit footprint (except for those existing STs with larger values as listed in Table5-2) and is uniformly distributed across each unit (one set of five individual STs or a single ET) (Phifer et al., 2009).	✓	✓				✓
E.36	No organic or inorganic materials known to enhance radionuclide mobility or solubility (e.g., chelating agents) are disposed in the waste stream beyond that assumed in this PA.	✓	✓	✓	✓	✓	✓
E.37	The properties of the waste as specified by the generator are the same as or bounded by those analyzed in this PA.	✓	✓	✓	✓	✓	✓
E.38	Cellulose degradation products (CDP) were not present in sufficient concentrations in the GW beneath the ORWBG (a closed solid-waste burial ground) to warrant application of a CDP correction factor to any K_d values for E-Area (Kaplan, 2012).	✓	✓	✓	✓	✓	
E.39	Existing CIG SWF inventories are handled on a segment basis with dates for each disposal consistent with the final closure of each segment (Table 4-24).	✓					
E.40	Many low-strength containers (B-25 boxes, tankers, and SeaLands) with significant interior void space were placed in CIG trench segments 4, 5, 6, and 7. During the operational and IC periods, these segments are delineated and protected from significant loads (e.g., soil stockpiles and heavy equipment).	✓					✓
E.41	Multiple CIG SWFs disposed and grouted in the same excavation are considered equivalent to disposing of a single component and subject to the same operational and engineering requirements (Wilhite, 2002).	✓					
E.42	The design volume of disposed waste is approximately 1,040,000 ft^3 for a ST (16-foot deep x 20-foot wide x 650-foot long x 5 trenches) and approximately 1,100,000 ft^3 for a single ET (equivalent of 12,000 B-25 boxes) [Sections 2.2.3.2 and 2.2.4.2].	✓	✓				
E.43	The design volume of disposed waste is approximately 1,100,000 ft^3 (equivalent of 12,000 B-25 boxes) for the LAWV (Section 2.2.5.2).			✓			
E.44	The design volume of disposed waste is approximately 257,000 ft^3 for the ILV (Section 2.2.6.2).				✓		
E.45	Actual DU areal footprints, effective waste-zone areal footprints, uncompacted/uncollapsed and compacted/collapsed waste-zone heights, and effective waste-zone volumes are used in GW, IHI, air, and radon pathways analyses (Hamm, 2022)	✓	✓	✓	✓	✓	
E.46	No additional disposals of NR components are planned in NR07E (operationally closed in calendar year 2005; Section 4.7).					✓	✓
E.47	For NR casks, welds are composed of a material and thickness such that no less than 1 cm of the material remains after 500 years. A weld that is nominally 1.6-inch thick, but no less than 1.25-inch thick, on the representative cask meets this minimum requirement (Wohlwend and Butcher, 2018).					✓	
E.48	Waste disposed in an ET is to reside within the waste zone footprint corresponding to its base; no waste is to be placed within its side slopes (Section 2.2.4.2).		✓				✓
E.49	At least 4 feet of operational soil cover is placed on top of all waste in the ET (Section 2.2.4).		✓				✓
E.50	To the extent practical, non-crushable containers should not be clustered together; instead, they should be distributed spatially throughout the waste zone (Sections 2.2.3.4 and 2.2.4).	✓	✓				✓
E.51	TPBAR disposal containers are placed in up to two stacks of two containers each (2 x 2 = 4 containers) near each of the two outer walls of the ILV cells [up to a total of 8 per cell] (Section 4.6.3.3).				✓		✓
E.52	During the operational period (Years 0 – 71), waste containers are placed in the ILV which is open to the atmosphere while waste is being placed. When not in use, a sloped rain cover is used to keep rainwater out (Section 2.2.6.3).				✓		✓
E.53	All previously disposed M-Area Glass SWFs are bounded by this PA based on the SA by Cook and Yu (2002) as described in Section 4.2.4.	✓					
E.54	To protect the critical assumption of a 30-year delayed release of tritium from ETF-activated carbon vessels buried in STs: (1) Ensure generator seals all openings to ETF activated-carbon vessels with a ¼-inch weld or equivalent closure; (2) Place ETF carbon columns vertically in an upright position in the trench to help ensure that the vessel withstands earth pressure in a ST environment during the operational period; (3) Prohibit dynamic compaction of STs containing ETF carbon columns until the end of the 30-year operational period; (4) Do not place ETF vessels within a minimum of 16 feet of wastes with high chloride content or cementitious waste to protect the assumed corrosion rate and waste-specific I-129 K_d, respectively; (5) Distribute ETF carbon vessels throughout the trenches to protect the assumption of uniform distribution of radionuclide inventory throughout the trenches.	✓					✓
E.55	Disposal containers for surface-contaminated auxiliary equipment (e.g., pumps and closure heads) are less robust and may be disposed in NRCDAs without meeting the first six requirements listed in Section 5.6.3 of the 2008 ELLWF PA.					✓	✓
E.56	In the GW analysis, K- and L-Basin resins disposed in the ILV beyond those reported in WITS as of March 24, 2008, are placed in any vault cell with the exception of Cell #4. Inventory of C-14K disposed in ILV Cell #4 before that date is managed as generic waste form C-14, i.e., using the C-14 limit for generic waste forms.				✓		✓
E.57	TPBAR disposal containers are assumed to remain intact throughout the compliance period (Hiergesell, 2005).				✓		
F. Facility and Container Structural Stability							
F.1	All CIG trench segments are assumed to be hydraulically intact for the first 40 years (Section 4.1.1.3.2).	✓					
F.2	CIG-1 through CIG-3 have no subsidence potential (Section 8.3.3.1.2).	✓					
F.3	CIG-4 through CIG-9 have subsidence potential, while CIG-8 and CIG-9 have a reinforced-concrete mat delaying subsidence potential for an additional 300 years [Peregoy (2006a) and Section 2.2.1.1]. No concrete mats are required for CIG-1 through CIG-7 (Section 8.3.3.1.2).	✓					✓
F.4	CIG-4 through CIG-7 contain both (1) components and (2) low-density waste that are not filled with grout, and are estimated to have an average of 7 feet of subsidence potential [Nichols and Butcher (2020) and Section 4.1.1.3.3].	✓					
F.5	For CIG-4 through CIG-7, a bounding subsidence base case assumes that subsidence occurs immediately at the end of IC. For CIG-8 and CIG-9, the best estimate subsidence case assumes that subsidence occurs 200 years after the end of IC (Section 4.2.1.2).	✓					
F.6	Vault collapse occurs when the roof fails. The time of roof failure is based on the most probable result from the respective structural analysis. LAWV and ILV structural failures occur 2,976 years and 5,771 years, respectively, after start of ELLWF operations (Sections 4.5.3 and 4.6.3).			✓	✓		
F.7	The subsidence potentials assumed for the LAWV and ILV are 21 feet and 17 feet, respectively (Sections 4.5.1.2 and 4.6.1.2).			✓	✓		

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
F. Facility and Container Structural Stability							
F.8	Radionuclide decay and corrosion of the outer bolted containers starts on the date the NRCDA receives waste (Section 4.7.8.5.1).					✓	
F.9	The robust, welded NR casks are structurally stable for thousands of years after placement on the NRCDA pads based on estimated corrosion rates (Wohlwend and Butcher, 2018).					✓	
F.10	Due to the robust nature of NR bolted container and welded cask designs and the density of the internal components and equipment they contain, significant subsidence is not considered feasible (Section 4.7.8.5.1).					✓	
F.11	Corrosion inside the cask is insignificant due to the negligible amount of water present in the casks prior to being welded closed. Corrosion penetrates the welds 750 years after burial, allowing water to enter the disposal casks via small holes in the welds [i.e., hydraulic failure] (Section 4.7.8.5.1).					✓	
F.12	Corrosion of waste material does not begin until hydraulic failure of the NRCDA welded casks [750 years after burial] (Sections 4.7.7.1 and 4.7.7.2).					✓	
F.13	To simplify the analysis, all welded casks and bolted containers are assumed to hydraulically fail simultaneously at the times provided in the timelines for NR07E and NR26E in Tables 4-78 and 4-79, respectively. Likewise, release of radionuclides from hydraulically failed welded casks and bolted containers occurs at the same time.					✓	
G. Groundwater Pathway Model							
G.1	Model gridding conforms sufficiently close to the dimensions and configuration of zone materials to adequately simulate flow and transport (Phifer et al., 2009).	✓	✓	✓	✓	✓	
G.2	The lateral extent of each VZ model is assumed to be sufficiently beyond the exterior waste zones of a DU to ensure near vertical flow along the boundary and, therefore, justify the use of a "no-flow" boundary condition (Chapter 4).	✓	✓	✓	✓	✓	
G.3	Cover materials are not modeled explicitly; they are represented by water infiltration rate boundary conditions across space and time (Danielson, 2019c).	✓	✓	✓	✓	✓	
G.4	Infiltration rates for the final closure cap are based on a bounding conceptual infiltration model that incorporates the cap's geometry (e.g., a long slope and a short slope) (Danielson, 2019c).	✓	✓				
G.5	Subsidence infiltration rates are computed based on the location along the cap crest and the size of the subsided region (Section 4.2.1.2).	✓	✓				
G.6	The overall length and the positioning of the CIG trench segments with respect to the crest of the final closure cap is accounted for when computing the infiltration rates (e.g., some CIG segments fall along the cap crest, some along the short slope, and some along the long slope of the bounding conceptual infiltration model – the upslope area to the cap is computed for each CIG trench segment) (Danielson, 2020c).	✓					
G.7	For STs and ETs, three subsided locations are considered where their computed fluxes to the water table are blended [i.e., assumed to be equally likely subsidence events] (Section 5.1.3).	✓	✓				
G.8	Infiltration rates calculated using the HELP model bound all plausible infiltration rate scenarios during the compliance period (Dyer, 2019b).	✓	✓	✓	✓	✓	
G.9	Averaged steady-state infiltration rates for all time periods (calculated by averaging estimated infiltration rates from the start and end of each period) are employed in each VZ flow model, which is consistent with an overall water balance (Chapter 4).	✓	✓	✓	✓	✓	
G.10	Infiltration rates for intact scenarios (Case01) over STs and ETs change as calculated using HELP model [Dyer (2019b) and Sections 3.8.4 and 4.2.1.2].	✓	✓				
G.11	Infiltration rates for several subsidence scenarios (Case11's) over STs and ETs are based on multiple hole-location configurations and supporting analyses (Section 4.1.3.6).	✓	✓				
G.12	ILV concrete and waste-zone transport properties are retained despite the reassignment of flow properties to those of operational soil cover, until the time of vault roof collapse (Section 4.6.3.8.1).				✓		
G.13	LAWV concrete transport properties are retained despite the reassignment of flow properties to those of operational soil cover, until the time of vault roof collapse (Section 4.5.3.8.1).			✓			
H. Groundwater Pathway Contaminant Release and Transport							
H.1	Generic key model inputs are as follows: infiltration results, element K_d values, material properties, radionuclide decay properties, hydrostratigraphic data, LAWV and ILV design specifications, aquifer mesh and flow, and plume interaction factors.	✓	✓	✓	✓	✓	
H.2	Local climate conditions continue to remain relatively unchanged throughout the compliance period (Leigh, 2008). Note that infiltration rates and GW conditions associated with alternative climate conditions are evaluated as part of the sensitivity and uncertainty analyses for each DU type (Chapter 6).	✓	✓	✓	✓	✓	
H.3	Separate 1-D infiltration rate analysis to generate boundary conditions for use in a series of steady-state VZ flow fields being applied to VZ transient transport is considered adequate (versus coupled surface conditions with transient flow and transport analysis).	✓	✓	✓	✓	✓	
H.4	For nominal PA calculations, annual average rainfall remains constant throughout the simulation period (Section 1.12.11).	✓	✓	✓	✓	✓	
H.5	Time-step sizes and mesh sizes are adequate, and numerical dispersion is not significant (Section 1.12.11).	✓	✓	✓	✓	✓	
H.6	Depth to the water table does not change from the base-case value throughout the analysis period (Section 1.12.11).	✓	✓	✓	✓	✓	
H.7	Assuming secular equilibrium for decay-chain members with half-lives less than 1 year is considered adequate at and beyond the 100-meter POA (Section 1.12.11). Note that some short-lived daughters may not remain in secular equilibrium because they are transported at a different rate than the parent radionuclide.	✓	✓	✓	✓	✓	
H.8	The time lag between characterization and disposal is typically short enough that decay of disposed radionuclides to potentially more problematic daughters during the time lag is ignored (Section 1.12.11).	✓	✓	✓	✓	✓	
H.9	Representative conceptual model geometries of STs and ETs are grouped based on DUs with similar hydrostratigraphic features (Danielson, 2020b).	✓	✓				
H.10	3-D models are necessary to capture geometric effects of STs and ETs; subsidence holes in different locations; and STs and ETs situated along the central, corner, or edge regions of the interim and final closure caps (Danielson, 2019a; 2019b; 2019c; Danielson, 2020a; 2020b).	✓	✓				
H.11	A generic geometry is used for subsidence regions, where the width of the subsidence region is bounded by the width of a ST segment (20 feet) and the length of the region is computed based on the percentage of the trench footprint that is subsided (Danielson, 2019a; 2019b; 2019c; Danielson, 2020a; 2020b).	✓	✓				
H.12	All LAWV openings and penetrations are sealed with materials that are assumed to have hydraulic properties equivalent to that of ELLWF vault concrete (Table 4-48).			✓			✓
H.13	When the final closure cap is placed, the roof and walls of the LAWV and ILV experience limited non-through static cracking (Sections 4.5.3.1 and 4.6.3.9.4). This is modeled using blended hydraulic properties based on a concrete and gravel mixture (Section 4.5.3.6).			✓	✓		
H.14	For LAWV and ILV, concrete hydraulic properties fully degrade over a 500-year period following placement of the final closure cap (Sections 4.5.1.1 and 4.6.1.1).			✓	✓		
H.15	Tritium and Ar-39 are the only radionuclides that escape from the TPBAR disposal containers in the ILV at a level of concern during the compliance period (Section 4.6.3.6).				✓		

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
H. Groundwater Pathway Contaminant Release and Transport							
H.16	For LAWV and ILV, hydraulic conductivity and saturation of degraded concrete are calculated using geometric averaging of ELLWF vault concrete and operational soil cover properties (Sections 4.5.3.6 and 4.6.3.5).			✓	✓		
H.17	For LAWV and ILV, fully degraded concrete has the hydraulic properties of operational soil cover (Nichols and Butcher, 2020).			✓	✓		
H.18	For LAWV, gravel physical properties represent vault waste material until vault collapse (Nichols and Butcher, 2020).			✓			
H.19	For LAWV and ILV, operational soil cover physical properties represent vault waste material after vault collapse (Nichols and Butcher, 2020).			✓	✓		
H.20	For LAWV and ILV, 2-D modeling of VZ cross sections is considered to be sufficient. This assumption neglects interior walls between vault cells and other features such as the AASHTO bridge beams supporting the LAWV roof that may cause local 3-D flow patterns within the vaults and vault cells (Sections 4.5.3.4 and 4.6.3.3).			✓	✓		
H.21	For LAWV and ILV, changes in concrete sorption properties follow the pore volume exchanges and K_d values recommended in the 2016 geochemical properties database (Kaplan, 2016b).			✓	✓		
H.22	NR waste shipping and disposal casks remain watertight and airtight for 750 years (Section 2.2.7.6).					✓	
H.23	Radionuclides associated with the activated metal corrosion products (bolted containers) are released in two cases: early hydraulic failure of seals on all bolted containers when soil is mounded over the pads (base case) and late hydraulic failure of seals on all bolted containers 750 years after burial (bounding case) [Tables 4-82 and 4-83].					✓	
H.24	Radionuclides associated with activated metal (welded casks) are released upon hydraulic failure beginning 750 years after burial at a rate determined by the corrosion rate of the alloy (Wohlwend and Butcher, 2018). [Based on corrosion rates and average component thicknesses, corrosion time periods are 16,079 years for Inconel and 104,349 years for Zircaloy.]					✓	
H.25	The U.S. EPA primary drinking water standards for radionuclides are the performance measures for GW protection (U.S. EPA, 2000; 2002).	✓	✓	✓	✓	✓	
H.26	After subsidence of CIG segments occurs, no hydraulic credit for the grout chamber materials is used.	✓					
H.27	Backfill and natural soil material acquire K_d values assigned to sandy sediment or clayey sediment.	✓	✓	✓	✓	✓	
I. Groundwater Pathway Material Flow Properties							
I.1	The choice of physical and hydraulic properties of the materials comprising the disposal system is based on a hierarchy of best available data (Section 3.8.3). Selection and assignment of material properties where data are lacking (e.g., waste zone properties) is based on professional judgment after considerable debate among modelers and analysts. Thus, these inputs are assumed to be most valid for incorporation into the VZ and aquifer zone models (Phifer et al., 2009).	✓	✓	✓	✓	✓	
I.2	HWCTR and the HXs apply flux-to-the-water-table source terms from previous ELLWF SAs and UDQEs (Hamm et al., 2012; Hamm and Smith, 2010) [Table 5-7 in Section 5.1.4.2].	✓					
I.3	232-F concrete rubble is not modeled; generic waste form H-3 inventory limits are bounding and are used for H-3F (Table 5-7 in Section 5.1.4.2).	✓					
I.4	The parameters and distributions for NRCDAs in Tables 6-43 and 6-44 account for the uncertainty in groundwater calculations (Nichols and Butcher, 2020).					✓	
I.5	The waste-zone material properties for LAWV and ILV in this PA are adequate (Sections 4.5.1.1 and 4.6.1.1, respectively). For example, hydraulic properties for CLSM are assigned to the waste zone.			✓	✓		
I.6	The material properties used for non-waste zones in this PA are adequate. For example, anisotropy has been introduced since the latest published analysis. If testing is performed, the material properties likely will change.	✓	✓	✓	✓	✓	
J. Groundwater Pathway Material Transport Properties							
J.1	Although PORFLOW allows the flexibility of specifying different values for effective, total, and diffusive porosities, a single porosity value is employed for each material type within the VZ and a single effective values is employed within the aquifer units (Phifer et al., 2009).	✓	✓	✓	✓	✓	
J.2	Particle density values are obtained from the Hydraulic Data Package (Phifer et al., 2009).	✓	✓	✓	✓	✓	
J.3	Molecular diffusivity applies to all elements.	✓	✓	✓	✓	✓	
J.4	K_d values are element- and material-specific and are obtained from the appropriate best estimate values available. When site-specific K_d values are not available, using K_d values for similar elements and material types is considered adequate (Kaplan, 2016b).	✓	✓	✓	✓	✓	
J.5	Backfill and natural soil material acquire K_d values assigned to sandy sediment or clayey sediment (Kaplan, 2016b). K_d assignments for these material zones are described in the applicable DU sections.	✓	✓	✓	✓	✓	
J.6	The half-lives of all radionuclides are obtained from the SRNL Rad Dose Package (SRNL (2019b).	✓	✓	✓	✓	✓	
J.7	Cementitious materials chemical aging is consistent with that outlined by Kaplan (2016b), occurs in parallel (rather than sequentially) based on the pore volume exchanges that occur over time, and is accompanied by changes to K_d values.	✓	✓	✓	✓		
J.8	Cementitious materials proceed through three geochemical stages as they age as described in Kaplan (2016b). The transition from Stage 1 to Stage 2 occurs after 50 pore volumes; from Stage 2 to Stage 3 after 500 pore volumes, from Stage 3 to Stage 4 after 4,000 pore volumes (Kaplan, 2016b).	✓	✓	✓	✓		
J.9	CLSM has characteristics of a cementitious material with respect to contaminant transport (i.e., pH range greater than 10) (Hiergesell, 2005).			✓	✓		
K. GoldSim® Trench System Model							
K.1	All radionuclide inventory is treated as "generic," meaning it is immediately available for release at the time of emplacement (Section 4.4.1).	✓	✓				
K.2	The closure cap and backfill are not explicitly modeled (Section 4.4.9).	✓	✓				
K.3	The lengths and widths of all STs and ETs are the same. Specially, all ETs are represented by one single geometry, as are those for all STs. However, the generic ET and generic ST geometries differ (Sections 4.4.8 and 4.4.9).	✓	✓				
K.4	PORFLOW-generated coupled flow rates and saturation values for the bounding subsidence case for hole location "2" are used as input to the GoldSim® Trench System Model in the form of flow velocity and soil saturation time-series elements for each layer in the unsaturated zone (Section 4.4.3.2).	✓	✓				
K.5	ST06, ST09, and ET06 are modeled and calibrated against PORFLOW output within the GoldSim® Trench System Model (Section 4.4).	✓	✓				

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
K. GoldSim® Trench System Model							
K.6	Uncertainties in the material property values reported in Table 4-38 for the two VZ soils and waste zone are based on statistical evaluation of site-specific field and laboratory data or literature data as described by (Nichols and Butcher, 2020).	✓	✓				
K.7	Uncertainty distributions for K_d values are derived from recommendations by (Kaplan, 2016b).	✓	✓				
K.8	The stochastic elements within the GoldSim® Trench System Model are listed in Table 4-39.	✓	✓				
K.9	The initial waste zone trench height is 16 feet. The heights of the NDC and DC waste zone sections for ETs are 13.5 and 2.5 feet, respectively; and for STs 4.9 and 11.1 feet, respectively.	✓	✓				
K.10	The GoldSim® sensitivity and uncertainty simulations use a unit inventory of 1 gmole of each radionuclide.	✓	✓				
L. Air and Radon Pathways Contaminant Release and Transport							
L.1	Radionuclide migration from the waste zone to the land surface occurs by vertical only diffusion in vapor filled pores. Migration or releases into the liquid phase are not accounted for (Section 3.6.1) (Hiergesell and Taylor, 2011).	✓	✓	✓	✓	✓	
L.2	Releases from the waste zone do not occur until operational closure (Section 3.6.1.1).	✓	✓	✓	✓	✓	
L.3	Operational closure occurs on the same date for all DUs (Section 3.6.1.1).	✓	✓	✓	✓	✓	
L.4	Waste is introduced 71 years before radon release from the waste zone commences (Section 3.6.3.2.1).	✓	✓	✓	✓	✓	
M. Inadvertent Human Intruder Pathway							
M.1	IHI is not possible during the operational and IC periods because of the presence of facility security (Section 1.12.1).	✓	✓	✓	✓	✓	
M.2	No federal protection of the SRS is assumed beyond the 100-year period of IC (Section 1.12.1).	✓	✓	✓	✓	✓	
M.3	After final closure in calendar year 2165, institutional controls and memory are lost, and inadvertent human and biotic intrusions are possible (Smith et al., 2019).	✓	✓	✓	✓	✓	
M.4	The IHI period of performance is 1,000 years (i.e., from Year 171 to Year 1,171), beginning in calendar year 2165 (end of IC) and extending to calendar year 3165 (Sections 1.7.2 and 7.0).	✓	✓	✓	✓	✓	
M.5	IHI calculations are performed twice, representing two cases with separate assumptions regarding the timing of waste disposal (Section 7.2). Case 1 Assumptions: • DUs opened before 2021: All waste buried at time of opening • DUs opened 2021 or later: All waste buried 09/30/2021 Case 2 Assumptions: • DUs closed before 2021: All waste buried at time of closure • DUs planned for closure 2021-2040: All waste buried 09/30/2040 • DUs planned for closure after 2040: All waste buried 09/30/2065 For each radionuclide, the dose factor and inventory limit are derived from the more pessimistic case.	✓	✓	✓	✓	✓	
M.6	Six stylized IHI scenarios are considered (Section 7.1): • Basement Construction: Acute exposure as IHI excavates a 3-meter-deep basement for a home, penetrating waste. • Well Drilling: Acute exposure as IHI drills a well through waste and brings cuttings to surface. • Discovery: Acute exposure as IHI excavates into closure cap but stops after encountering erosion barrier. • Agriculture: Chronic exposure to waste brought to surface by previous basement construction. • Post-Drilling: Chronic exposure to waste brought to surface by previous well drilling. • Residential: Chronic exposure in a house with a basement excavated above waste but not penetrating waste.	✓	✓	✓	✓	✓	
M.7	Basement construction and agriculture scenarios apply only to ST23 (Table 7-4). All other DUs are precluded because concrete roofs (LAWV, ILV), steel casks (NRCDAs), steel waste forms (HWCTR in ST14), and depth of waste (other STs and ETs) pose effective barriers to normal residential basement excavation during the entire 1,000-year compliance period.	✓					
M.8	Basement and agricultural scenarios apply to the CIG trench segment in ST23. The grout encapsulation is sufficiently robust to resist dynamic compaction at closure; therefore, some waste remains within the 3-meter depth required for the basement scenario. Grout degrades later and becomes sufficiently friable to be excavated within the 1,000-year compliance period.	✓					
M.9	Well drilling and post-drilling scenarios apply only to STs and ETs (Table 7-4). Other DUs have drill-resistant concrete roofs (ILV, LAWV) or drill-resistant steel casks (NRCDAs) which preclude penetration during the entire 1,000-year compliance period.	✓	✓				
M.10	Discovery and residential scenarios apply to every DU (Table 7-4).	✓	✓	✓	✓	✓	
M.11	Exposure pathways caused by bio-intrusion into the waste layer by burrowing animals bringing contaminated soil to the surface are precluded - based on the presence of an erosion barrier in the final closure cap design (Section 1.12.1).	✓	✓	✓	✓	✓	
M.12	Assumptions regarding exposure parameters (e.g., amount of time spent drilling well) are given by Smith et al. (2019).	✓	✓	✓	✓	✓	
M.13	The external dose rate (discovery and residential scenarios) drops with increasing shielding thickness up to 1 meter. For shielding thickness greater than 1 meter, the dose rate assumes the value at 1 meter.	✓	✓	✓	✓	✓	
M.14	For each currently open (2022) DU, the average composition of its waste at closure in calendar year 2065 is assumed to be the same as it was in March 2021.	✓	✓	✓	✓	✓	
M.15	For each future trench DU, the projected composition of its waste at closure in calendar year 2065 is assumed to be the same as a similar identified DU (or group of DUs).	✓	✓				
M.16	Radionuclide decay is the only mechanism by which the source is reduced; no leaching of radionuclides to GW is assumed in the IHI analysis (Section 8.4).	✓	✓	✓	✓	✓	

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
N. Air Pathway							
N.1	Because exposures via the air pathway will occur at different times, locations, and with increased variability (i.e., varied wind direction) compared to exposures via the GW pathways, contributions from the air transport pathway are considered separately.	✓	✓	✓	✓	✓	
N.2	The air flow field is assumed to be isobaric and isothermal (Section 3.6.1).	✓	✓	✓	✓	✓	
N.3	The impacts from naturally occurring fluctuations of atmospheric pressure (barometric soil venting) are assumed to be small (Section 3.6.1).	✓	✓	✓	✓	✓	
N.4	Air is the medium through which all diffusion occurs. Diffusion in the aqueous phase is ignored because the diffusion rates in water are negligible compared to rates in air (Section 3.6.1.1).	✓	✓	✓	✓	✓	
N.5	Radioactive source decay and diffusive air releases that occur during operations are not accounted for in the simulations (waste is placed at the end of operations) (Section 3.6.1.1).	✓	✓	✓	✓	✓	
N.6	The water phase is assumed to be stationary (Section 3.6.1.1).	✓	✓	✓	✓	✓	
N.7	The top layer of the closure cap is the erosion barrier when calculating flux (when the closure cap is in place) (Section 3.6.1.1).	✓	✓	✓	✓	✓	
N.8	Partitioning between phases is at equilibrium (Sections 3.6.1.7 and 3.6.1.8).	✓	✓	✓	✓	✓	
N.9	The 6-inch topsoil and 30-inch upper compacted backfill layers of the closure cap have eroded, thereby reducing the diffusive length by 36 inches (Section 3.6.1.1).	✓	✓	✓	✓	✓	
N.10	C-14 exists as part of the CO_2 molecule; therefore, the gas-phase concentration of C-14 in the waste zone is controlled by carbonate chemistry.	✓	✓	✓	✓	✓	
N.11	H-3 exists as a triatomic gas (Table 3-43).	✓	✓	✓	✓	✓	
N.12	Hg-194, Hg-203, Kr-85, Kr-81, and Kr-83m exist as monatomic gases (Dyer, 2017d).	✓	✓	✓	✓	✓	
N.13	Following operational closure of the ILV (Year 46), a minimum 3-inch-thick layer of Grout/CLSM and a reinforced concrete roof are placed above the ILV waste zone (Section 4.6.3.1).				✓		✓
N.14	During the post-closure compliance period (Year 171 – 1,171), a closure cap is added above the ILV reinforced concrete roof (as depicted in Figure 2-76).				✓		✓
N.15	The ILV remains structurally intact for the 1,171-year compliance period (Section 4.6.1).				✓		
N.16	The inventory of volatile Ru-106 is negligible at closure for all DUs.	✓	✓	✓	✓	✓	
N.17	Volatile UF_6 and volatile fluorides of other elements are not present at closure in any DU.	✓	✓	✓	✓	✓	✓
N.18	DRFs are calculated for the MEI by representing DUs as a point source; adopting ground-level release of radionuclides above the DU; assuming radionuclide release over a period of one year; and assuming the receptor stands in the plume centerline and receives continuous exposure over the entire year (Section 3.6.2.2.4).	✓	✓	✓	✓	✓	
N.19	100% spatial overlap of atmospheric plumes is assumed at the site boundary and 100-meter POAs (Section 3.6.2.3.1).	✓	✓	✓	✓	✓	
O. Radon Flux Pathway							
O.1	The radon emanation factor is 0.25 (Yu et al., 2001) and Section 3.6.3.2.3.	✓	✓	✓	✓	✓	
O.2	The top layer of the closure cap is the erosion barrier when calculating flux (when the closure cap is in place) (Section 3.6.1.1).	✓	✓	✓	✓	✓	
O.3	The air flow field is assumed to be isobaric and isothermal (Section 3.6.1).	✓	✓	✓	✓	✓	
O.4	The impacts from naturally occurring fluctuations of atmospheric pressure (barometric soil venting) are assumed to be small (Section 3.6.1).	✓	✓	✓	✓	✓	
O.5	Rn-222 parent radionuclides are stationary (nearly non-volatile elements that remain in the waste zone) (Section 3.6.3.2).	✓	✓	✓	✓	✓	
O.6	Vapor-phase diffusion occurs upward towards the land surface [i.e., zero-flux boundaries on the vertical sides and base of the 1-D stack of GoldSim® computational elements] (Section 3.6.1.1).	✓	✓	✓	✓	✓	
O.7	The water phase is assumed to be stationary (Section 3.6.1.1).	✓	✓	✓	✓	✓	
O.8	Representing the ILV as a waste zone overlaid by a minimum 27 inches of concrete roof during the IC period (Years 71 – 171) is appropriate (as depicted in Figure 2-75).				✓		
O.9	Representing the ILV as a waste zone overlaid by a minimum 27 inches of a concrete roof and a minimum of 60 inches of soil/gravel materials forming the closure cap during the post-closure compliance period (Years 171 – 1,171) is appropriate as depicted in Figures 2-75 and 2-76).				✓		
P. All-Pathways							
P.1	Exposure pathways assessed are those detailed in SRNL-STI-2015-00056, Rev. 1 (Smith et al., 2019).	✓	✓	✓	✓	✓	
P.2	The all-pathways analysis assumes the exposure parameters contained in Excel workbook "Radionuclide, Element and Dose Parameter Data Package", Version 2.0, documented in Chapter 10 of SRNL-STI-2015-00056, Revision 1 (Smith et al., 2019).	✓	✓	✓	✓	✓	
P.3	The all-pathways analysis assumes the bio-transfer factors contained in Excel workbook "Radionuclide, Element and Dose Parameter Data Package", Version 2.0, documented in Chapter 10 of SRNL-STI-2015-00056, Revision 1 (Smith et al., 2019).	✓	✓	✓	✓	✓	
Q. Dose Parameter Settings and Analyses							
Q.1	Five independent exposure scenarios (i.e., Air, Radon, All-Pathways, Water Resources, Inadvertent Human Intruder) are addressed for the impact to a MOP over a range of compliance periods for the ELLWF (Table 1-2 in Section 1.7.1).	✓	✓	✓	✓	✓	
Q.2	Groundwater protection (GWP) in the water resource exposure scenario is addressed by analyzing the following four independent pathways: beta-gamma, gross-alpha, radium, and uranium (Table 1-2 in Section 1.7.1).	✓	✓	✓	✓	✓	
Q.3	For the GW and IHI exposure pathways, usage and exposure parameters for a "typical person" at the 50th percentile are employed (Section 3.7.1).	✓	✓	✓	✓	✓	
Q.4	For the air pathway, usage and exposure parameters for a "reference person" at the 95th percentile are employed (Section 3.6.2.2).	✓	✓	✓	✓	✓	
Q.5	The release mechanisms addressed for each primary pathway (GW, IHI, air, and radon) exclude those addressed for other pathways. This isolates the analyses [e.g., for GW analyses, the release of radionuclides from the waste zone due to volatilization and excavation processes is assumed to be zero] (Sections 8.3, 8.4, 8.5, and 8.6).	✓	✓	✓	✓	✓	
Q.6	For the GW pathways (i.e., GWP and all-pathways), the POA is set to the "at and beyond" region outside the 100-meter buffer zone surrounding the ELLWF DU footprints (Section 1.7.1).	✓	✓	✓	✓	✓	

Table A-4 (cont'd). List of Key Assumptions

Assumption No.	Key Assumption	ST	ET	LAWV	ILV	NRCDA	Operating Parameter
Q. Dose Parameter Settings and Analyses							
Q.7	The main transport mechanism for the IHI pathway is direct intrusion into the waste zone or excavation of areas near the waste zone (Section 3.7).	✓	✓	✓	✓	✓	
Q.8	For the GW pathways, the primary mechanism for transport of radionuclides to the MOP is expected to be leaching to GW, GW transport to the well at 100 meters, and subsequent internal or external human exposure (Section 3.7).	✓	✓	✓	✓	✓	
Q.9	For the air pathway, the POA is set to the "at and beyond" region outside of the SRS (Years 71 – 171 compliance period) followed by the 100-meter buffer zone surrounding the ELLWF DU footprints (Years 171 – 1,171 compliance period) [Section 1.7.1].	✓	✓	✓	✓	✓	
Q.10	For the radon pathway, the POA is set to the ground surface directly above each DU waste footprint (Section 1.7.1).	✓	✓	✓	✓	✓	
Q.11	For the IHI pathway, the POA is set to the ground surface directly above each DU waste footprint and the waste zone material directly due to excavation (Section 1.7.1).						
Q.12	The 1,000-year compliance period starts at the end of IC once dynamic compaction and application of the final cover occur (Section 1.7.2).	✓	✓	✓	✓	✓	

Notes:

Table rows highlighted in orange are an operational parameter.

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