STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
3100 Port of Benton Blvd • Richland, WA 99354 • (509) 372-7950
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September 30, 2021 21-NWP-173

Brian A. Harkins, Deputy Assistant Manager
Tank Farms Division
Office of River Protection
United States Department of Energy
PO Box 450, MSIN: H6-60
Richland, Washington 99352

Re: Department of Ecology's Responses to the United States Department of Energy's Proposed Disposition of Our Comment Submitted with Ecology Letter 21-NWP-044

References: Page 2

Dear Brian A. Harkins:

The Department of Ecology (Ecology) is submitting responses to the United States Department of Energy's (USDOE) proposed dispositions of our comments on document RPP-ENV-61497 (Reference 1) and RPP-ENV-62206 (Reference 2), in accordance with Section 9.2 of the Hanford Federal Facility Agreement and Consent Order (HFFACO) Action Plan.

Ecology recognizes the preliminary nature of these documents, which were written prior to performing retrievals, post-retrieval sampling, and vadose zone sampling in Waste Management Area (WMA) A-AX. Therefore, our comments are primarily intended to identify issues that we feel should be resolved before preparation of the full Appendix I Performance Assessment (IPA) and subsequent revisions that will incorporate results of sampling.

At this time, Ecology cannot rely on these preliminary documents to demonstrate the protectiveness of the proposed closure actions for WMA A-AX, or for incorporation into the Hanford site-wide permit, but we look forward to working collaboratively with USDOE to ensure that the full IPA meets these needs. We would also like to take this opportunity to reiterate that as part of the permitting process, Ecology will require assessments of the risks associated with existing contamination in the vadose zone, and all associated risk pathways for WMA A-AX, as described in Appendix I of the HFFACO.

Ecology would like to discuss our responses to the proposed dispositions of our comments with USDOE as soon as possible, so that we can work collaboratively on resolution of the identified issues.

If you have questions or concerns, please contact me at jeff.lyon@ecy.wa.gov or (509) 372-7914, or Beth Rochette, Chemist, at beth.rochette@ecy.wa.gov or (509) 372-7922.

Sincerely,

Digitally signed by Lyon, Jeffery (ECY)
Date: 2021.09.30 15:51:30 -07'00'

Jeffery J. Lyon
Tank Systems Operation & Closure Project Manager
Nuclear Waste Program

rb/aa
Enclosures (2)

References:

1. Document RPP-ENV-61497, Rev. 0, dated September 16, 2020, *Preliminary Performance Assessment of Waste Management Area A-AX, Hanford Site, Washington*
2. Document RPP-ENV-62206, Rev. 0, dated September 16, 2020, *Analysis of Post-Closure Groundwater Impacts from Hazardous Chemicals in Residual Wastes in Tanks and Ancillary Equipment at Waste Management Area A-AX at the Hanford Site, Southeast Washington*

cc electronic w/enc:

David Einan, EPA
Brian Vance, USDOE-ORP
Rod Lobos, USDOE-RL
Daniel Pearson, USDOE-RL
Jon Perry, HMIS
Marcel Bergeron, WRPS
Paul Rutland, WRPS
Mason Murphy, CTUIR
Jack Bell, NPT
Rex Buck, Jr., Wanapum
Laurene Contreras, YN
ERWM Staff, YN
Steve Weigman, HAB
David Reeploeg, Hanford Communities
Max Woods, ODOE
Scott Van Verst, WDOH
Jim Alzheimer, Ecology
Damon Delistraty, Ecology
Dib Goswami, Ecology
Deirdra Hahn, Ecology
Theresa Howell, Ecology
Jeff Lyon, Ecology
Nina Menard, Ecology
Beth Rochette, Ecology
Kyle Rucker, Ecology
Maria Skorska, Ecology
Jerry Yokel, Ecology
Environmental Portal
Hanford Administrative Record
Hanford Facility Operating Record
HMIS Correspondence Control
EPA Region 10 Hanford Field Office, Correspondence Control
USDOE-ORP Correspondence Control
USDOE-RL Correspondence Control
WRPS Correspondence Control

Review Comment Record

Document: RPP-ENV-61497, Rev. 00, Preliminary Performance Assessment of Waste Management Area A-AX at the Hanford Site, Washington

Ecology Comments

Date: March, 2021

Reviewer: DD, DG, JWL, BR, SVV, JWY

DOG1. General: Ecology has prepared comments for RPP-ENV-62206, Rev. 0, Analysis of Post-Closure Groundwater Impacts from Hazardous Chemicals in Residual Wastes in Tanks and Ancillary Equipment at Waste Management Area A-AX at the Hanford Site, Southeast Washington, in addition to the comments for this document. Some of the general comments for that document also apply to this document. They will not be repeated here, however. Ecology requests that they be considered when this document is revised. BR

USDOE Disposition 7/9/21
Response: Accepted. When updating the preliminary PA and RCRA Impacts Analysis to address review comments and new information, DOE will be consistent and make the same changes in both documents.

Ecology Response 9/21/21: Disposition accepted, pending revisions.

DOG2. General: Please clarify in the Executive Summary that this document evaluates groundwater impacts (via leaching) of waste contaminants in tank residuals and ancillary equipment without considering current groundwater contamination. DD

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next document revision have been updated. The second paragraph of the Executive Summary has been edited to include "The analysis is a post-closure analysis of residuals left in the single shell tanks, ancillary equipment and pipelines. The analysis start period is after the WMA is closed and covered with an engineered barrier. The analysis does not evaluate the cumulative impact with existing soil contamination or comingling with existing groundwater contamination."

Ecology response 8/30/21: Disposition accepted, pending revision.

DOG3. General: Comparison between A-AX and TC-WM EIS (ref: Section 1.5.2; Page 1-39): The text states that "although the mathematical models for the fate and transport of residual wastes in WMA A-AX may differ between the WMA A-AX PA and the TC & WM EIS, the conceptual models are consistent with each other. The results published in WMA A-AX do not isolate sources in WMA A-AX and therefore direct comparisons between the two models havenot been performed." In the past it has been observed different results using different mathematical models in the same conceptual models. Therefore, a direct comparison is necessary between the TC-WM EIS and the WMA A-AX. DG

USDOE Disposition 7/9/21

Response: Not accepted. RPP-ENV-61497 is an analysis of impacts from residual waste left in the single-shell tanks and ancillary equipment in A farm and in AX-Farm. The analysis reports the groundwater and air impacts from individual single-shell tanks and a consolidated source for the pipelines and ancillary equipment. The TC & WM EIS does not provide long-term risk analysis results at this level of detail to compare to. Appendix Q in the TC & WM EIS presents results for a consolidated suite of sources under the "A Barrier". As described in TC & WM EIS Figure E-31, the "A Barrier" includes sources in WMA A-AX as well as C Tank Farm, AN Tank Farm, AP Tank Farm, AW Tank Farm, AY Tank Farm, AZ Tank Farm, and the 242-A Evaporator. Because the A Barrier results include so many additional sources beyond A Tank Farm and AX Tank Farm it is not possible to directly compare the WMA A-AX PA results in RPP-ENV-61497 to the published A Barrier results in the TC & WM EIS.

Many aspects of the modeling approach used in the TC &WM EIS are very similar to that used in the WMA A-AX Preliminary PA, including similar estimates of the sequence of pre-closure and post-closure recharge rates, the use of EHM approach for using homogeneous hydraulic properties for major HSU's, grid discretization, and the use of similar distribution coefficients for major contaminants of potential concern. DOE's position is that, if the same residual inventories, recharge, and waste release models that were used in the EIS models of the WMA A and AX areas were used for the WMA A-AX model that results of releases to the water table for the two models would be comparable. This is supported by the assessment that had been performed for the WMA C PA that was documented in Appendix G of RPP-ENV-58782. For that comparison, the TC & WM EIS published a result from WMA C that could be used as a comparison; there is no equivalent result for WMA A-AX so this analysis cannot be repeated for WMA A-AX.

DOE would also like to point out that relevance of the TC&WM EIS modeling approach which was completed over 10 years ago to current modeling efforts in tank farms and other waste sites is no longer as important as it was in the past; the DOE letter requiring Hanford Site modeling subcontractors to maintain consistency with the TC & WM EIS has been rescinded by DOE.

Ecology Response: 9/22/21: This needs to be discussed further especially on the last paragraph of the DOE's response dealing with the relevance of the TCWM EIS modeling approach vs. other approaches. We believe it is still relevant as far as the approach and other related aspects are concerned. Let us discuss to clarify our mutual understandings.

DOG4. Executive Summary, p. ES-5, lines 16-40; Section 6.2.1, p. 6-77, Table 6-10: Please clarify if sensitivity cases are limited to the effect of single parameter changes on peak groundwater concentration/time (e.g., p 6-2, lines 40-41). If so, note that these analyses (which change one factor at a time) are useful in isolating the effect of a single parameter on the output but do not address the effect of interactions among multiple parameters on groundwater concentration over time. DD

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next PA revision have been updated with the following

text: "The deterministic sensitivity analyses evaluate a change in a safety function and adjust affected conceptual models and parameter values to align with the change in the safety function. These sensitivity analyses are useful for isolating the effect of a safety function to develop an understanding of how that safety function affects the performance of the entire system when closed. Sensitivity studies evaluating scenarios that degraded multiple safety functions simultaneously, relative to the expected evolution of the safety functions, are not specifically addressed."

Ecology response 8/30/21: Disposition accepted, pending revision.

DOG5. General: Because of the lack of characterization data for WMA A-AX residual wastes, the A-AX PA relies primarily on the extensive testing and analyses done for WMA C residual wastes. This is necessary as of 2019 because, unlike the WMA C PA, the initial WMA A-AX PA is deliberately being completed before any tanks in the WMA have been retrieved; thus, characterization of tank-specific residuals will not be possible until future updates to the PA. This makes it difficult for Ecology to have confidence in the results when this uncertainty is hard to quantify at this time. JWY

USDOE Disposition 7/9/21
Response: Accepted. RPP-ENV-61497 Revision 0 is considered by DOE to be a preliminary document necessary to build a technical foundation to assist in planning for future closure actions. Future updates to the PA will evaluate new information as it is learned.

Ecology Response 9/15/21: Disposition accepted.

DOG6. General: There is variability in each waste stream inventory concentration. It is not clear of what the variability is in the calculation of potential intruder impacts. The WMA C WIR had a discussion that provided a comparison of the Class C limits based on the WMA C PA 12 inventory estimates and the Class C limits based on the BBI inventory estimates updated with 13 post-retrieval samples for the five SSTs. JWY

USDOE Disposition 7/9/21
Response: At the time the preliminary PA was developed, retrievals in WMA A-AX had not begun. Therefore, assumptions about the residual inventory left in the tanks needed to be made based on available information in the BBI and flowsheet simulations. The significance of these assumptions was evaluated using sensitivity studies that changed the residual waste inventory and evaluated the impacts of those changes.

DOE Order 435.1 requires a waste-incidental-to-reprocessing (WIR) evaluation to determine whether spent nuclear fuel reprocessing plant wastes are incidental to reprocessing and can be managed as either transuranic waste or low-level waste, as appropriate. The WIR Evaluation has three requirements for managing reprocessing waste as low-level waste. The second requirement is that it must be demonstrated that the waste can be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR Part 61, Subpart C, Performance Objectives. RPP-ENV-61497 is the analysis for comparison to WIR Evaluation criterion #2. WIR Evaluation criterion #3 requires that waste will be incorporated into a solid physical form at a concentration that does not exceed the applicable

concentration limits for Class C low-level waste specified in 10 CFR 61.55, Waste Classification. The preliminary PA for WMA A-AX does not currently perform the evaluation for Criterion #3 because this evaluation would be premature at this time. The WMA A-AX source terms evaluated in the PA have not been retrieved so that there is significant uncertainties in the inventories that would be necessary to perform the comparison. As the retrieval in WMA A-AX progress, new information about the uncertainty and variability in waste volumes, inventories and concentrations for the different sources in WMA A-AX will be developed from post-retrieval sampling. The new information will be evaluated in future PA updates. These updates will include the impacts of updated waste information from post-retrieval sampling and may include a comparison to concentration limits for Class C low-level waste specified in 10 CFR 61.55, Waste Classification. As a requirement for the WIR Evaluation, the evaluation would, at a minimum, be performed and documented in the required WIR Evaluation.

Ecology Response 9/15/21: Disposition accepted.

DOG7. General: What is impact of A-AX to VLAW? WIR for WMAC shows its impact. In sum, this Draft WIR Evaluation demonstrates that the stabilized residuals, waste tanks, and 40 ancillary structures (including integral equipment) at the time of WMA C closure will meet 41 DOE M 435.1-1 criteria, are incidental to the reprocessing of SNF, are not HLW, and may be managed as LLW. JWY

USDOE Disposition 7/9/21

Response: Not accepted. RPP-ENV-61497 is a post-closure performance assessment analysis per DOE Order 435.1 of tank and ancillary equipment residuals and how releases from these sources might affect groundwater and members of the public in the future. The determination of waste incidental to reprocessing will be performed in a future document (WMA A-AX WIR). The cumulative effect of the waste residuals in WMA A-AX comingling with releases from the Hanford IDF (the disposal facility for VLAW) are evaluated in the Hanford Composite Analysis[1]. A revision of the Hanford Composite analysis in underdevelopment.

[1] Note, the Hanford Composite Analysis does not specifically provide results for residual releases from WMA A-AX comingling with releases from the IDF. The Hanford Composite Analysis shows the cumulative effects from all area sources, of which releases from WMA A-AX and IDF are included.

Ecology Response 9/15/21: Disposition accepted.

DOG8. General: Section 9.3 Future Work, puts this version of the PA in perspective as one document of many used for decision making. Along with the PA maintenance plan, the 435.1 composite analysis, closure plan, monitoring plan, new field data and annual reports represent a suite of information that needs to be made for final closure of the facility. Reviewers would bewell informed to read sections 9.2 and 9.3 prior to review. JWY

USDOE Disposition 7/9/21

Response: Acknowledged. Section 9.3 in RPP-ENV-61497 illustrates that RPP-ENV-61497 is preliminary post-closure analysis of the implications of leaving some residual radioactive waste in WMA A-AX tanks and ancillary equipment. This preliminary analysis was developed to provide DOE's regulating body the opportunity to provide early input into the modeling and analyses so that the performance assessment team can revise the models or collect additional

data, where necessary, prior to seeking closure authorization. RPP-ENV-62206 serves the same purpose for RCRA-regulated waste left in the tanks and ancillary equipment.

Ecology Response 9/15/21: Disposition accepted.

DOES1. Executive Summary, p. ES-7, para 4 (no line numbers): Define "non-negligible inventories." DD

USDOE Disposition 7/9/21

Response: Accepted. A future revision of the PA will clarify the radionuclide screening criteria and provide a quantitative value for minimum inventory considered. The smallest, non-zero inventory included in residual waste in the PA model was 3E-14 Ci. For non-radioactive constituents, the lowest initial inventory was 30 µg.

Ecology response 8/30/21: Disposition accepted, pending revision.

DOES2. Executive Summary, p. ES-7, last para (no line numbers); p. ES-8, Figure ES-5; Section 3.1, p 3-3, Figure 3-1: Please state whether or not the exposure pathways/receptors specified (i.e., groundwater, air, inadvertent intruder) are the only pathways/receptors explicitly required by DOE Order 435.1. Regardless of the DOE Order 435.1 requirement, acknowledge that there are other exposure pathways/receptors that have been omitted in Figures ES-5 and 3-1. For example, in conjunction with the human intruder scenario, terrestrial eco receptors could be exposed to contaminated soil brought to the surface after drilling activities (e.g., drill cuttings). Also, please add an arrow connecting the source term directly with contaminated soil media (as in Figures 7-2 to 7-5) to depict the intruder pathway (drill cuttings brought to surface soils, i.e., direct contaminant transfer to surface soils, neither via groundwater nor via air). DD

USDOE Disposition 7/9/21

Response: Partially Accepted. The native files for the next revision of the PA have been updated to clarify that the three exposure pathways discussed in this report are the three pathways required to compare to performance objectives and measures in DOE M 435.1-1. In addition, mentioning that other exposure scenarios, such as the one in the comment, can be evaluated, they are not evaluated in this document. In addition, Figure ES-5 has been divided into two figures so that the pathways for the intruder scenario are shown as well.

Ecology response 8/30/21: Disposition accepted, pending revision.

DOES3. Executive Summary, p. ES-8, last para (no line numbers); Section 3.1, p 3-3, Figure 3-1: Please state whether or not the exposure pathways/receptors specified (i.e., groundwater, air, inadvertent intruder) are the only pathways/receptors explicitly required by DOE Order 435.1. Regardless of the DOE Order 435.1 requirement, acknowledge that there are other exposure pathways/receptors that have been omitted in Figures ES-5 and 3-1. For example, in conjunction with the human intruder scenario, terrestrial eco receptors could be exposed to contaminated soil brought to the surface after drilling activities (e.g., drill cuttings). Also, please add an arrow connecting the source term directly with contaminated soil media (asin Figures 7-2 to 7-5) to depict the intruder pathway (drill cuttings brought to surface soils, i.e., direct

contaminant transfer to surface soils, neither via groundwater nor via air). DD

USDOE Disposition 7/9/21

Response: Partially Accepted. The native files for the next revision of the PA have been updated to clarify that the three exposure pathways discussed in this report are the three pathways required to compare to performance objectives and measures in DOE M 435.1-1. In addition, mentioning that other exposure scenarios, such as the one in the comment, can be evaluated, they are not evaluated in this document. In addition, Figure ES-5 has been divided into two figures so that the pathways for the intruder scenario are shown as well.

Ecology response 8/30/21: Disposition accepted, pending revisions.

DOES3. Executive Summary, p. ES-8, last para (no line numbers); Section 3.1, p. 3-2, lines 2-5: Text (p ES-8) states, "The surface water pathway is not a possible exposure pathway for the disposal facility because surface water is not present near WMA A-AX, …." Although surface water is not near WMA A-AX, transport of WMA A-AX contaminants from groundwater to riverwater/sediments could expose human and terrestrial/aquatic eco receptors to contaminants derived from tank residual waste (as WMA A-AX overlies the 200-PO-1 groundwater OU which abuts the river). DD

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been revised to acknowledge that "Per DOE Order 435.1 this performance assessment is a local-scale evaluation of impacts in the immediate vicinity of the landfill closed facility. Although groundwater flowing below the immediate vicinity of the WMA eventually flows towards and discharges to the Columbia River, the impacts to groundwater are evaluated locally and are below regulatory requirements in the immediate vicinity of the landfill closed WMA A-AX facility. Results of impacts to surface water and potential human and terrestrial/aquatic eco receptors from the residual waste left in the WMA once the groundwater reaches the Columbia River would be expected to be negligible."

Ecology response 8/30/21: Disposition partially accepted. Rather than expecting impacts to receptors (associated with surface water [Columbia River]) to be negligible, demonstrate this with modeling.

USDOE has divided this comment into 2 parts (a & b)

DOES4a. Executive Summary, ..p ES-10, Table ES-1; Section 5.3, p 5-14, lines 25: Re the "Atmospheric (40 CFR, Subpart H)" performance objective, explain "Screened out" in more detail in Table ES-1 (via a footnote). DD

USDOE Disposition 7/9/21

Response: Accepted. A footnote has been added to table ES-1 in the native file which reads: "RPP-CALC-63180, Calculation of Inhalation Doses from H-3, C-14,and I-129 Originating from Waste Management Area A-AX, concluded that the total inhalation dose (the exposure pathway contributing to the maximum air total dose among various air exposure pathways)

from the combined inventory of ^{129}I, ^{3}H and ^{14}C from all sources in WMA A-AX released from the ground surface in 2050 to a receptor at the Hanford Site boundary (24 km away) is orders of magnitude below the performance objective and is therefore screened out from further analysis."

Ecology response 8/30/21: Disposition accepted, pending revisions.

DOES4b It appears that footnote "d" is incorrectly placed in the last two lines of the table (12.3 pCi/L and 1.6E-3 pCi/L), since these values far exceed 1E-10 pCi/L (per the footnote). DD

USDOE Disposition 7/9/21
Response: Accepted. Because the footnote applies to radionuclide concentrations listed as 0, the superscript has been moved to the 3rd column.

Ecology response 8/30/21: Disposition accepted, pending revisions.

DO1-1. Section 1.6.6.3, p. 1-48: What is the uncertainty of using the *WMA C Single –Shell Tank Waste Management Area C Pipeline Feasibility Evaluation (RPP-PLAN -47559)* for the WMA A-AX waste management area for evaluating human intrusion? JWY

USDOE Disposition 7/9/21
Response: There is no uncertainty of using information developed for WMA C in RPP-PLAN-47559 for evaluating human intrusion at WMA A-AX. The information that was developed in RPP-PLAN-47559 but used in the WMA A-AX PA is that pipelines are assumed to contain approximately 5% waste by volume. The assessment in RPP-PLAN-57559 used available (but limited) observations of residual transfer material on pipe walls from Hanford Areas, not WMA C. The same value would have been derived if this PA developed the value from those sources instead of citing the work that had already been done in RPP-PLAN-47559. Citing RPP-PLAN-47559 is an expedient way of pointing to the full analysis. Summaries of the derivation from RPP-PLAN-47559 are provided elsewhere in the PA where the information is used. The 5% residual waste volume of the sidewalls of the pipe is uncertain, but as discussed in Section A.7.6 of RPP-ENV-61497, this assumed value is high compared to the observations at the other sites. It should be noted that in the intruder analyses, the equations simplify to a show that the intruder dose is proportional to the assumed waste volume for a given waste composition. Therefore, an intruder analysis with assumed 4% residual waste volume in the pipeline but the same radionuclide concentrations in the waste would have a total and individual radionuclide dose that is 80% of the values reported for the 5% residual waste volume in the PA. Similarly, intrusion into a pipeline with an assumed 10% residual waste volume would have an intruder dose that are double those for the assumed 5% residual waste volume in the PA in the PA. The maximum dose for a plugged pipeline would have a dose that is 20 times greater than the values reported in the PA.

Ecology Response 9/15/21: Disposition accepted.

DO2-1. Section 2.1.8. p. 2-100, lines 1-4: Text cites NCRP Report No. 93 for an estimate of background radiation dose in the U.S. (365 mrem/y). NCRP Report No. 160 (2009) updates NCRP Report No. 93 (1987). A key finding of the more recent NCRP Report No. 160 is that although the naturally occurring amounts of radiation have changed little, there has been a

dramatic increase in the amount of radiation from medical imaging procedures, resulting in anincrease in background radiation dose to the general public in the U.S. (620 mrem/y). NCRP Report No. 160 updates NCRP Report No. 93. Please revise the background radiation dose estimate (620 mrem/y), according to NCRP Report No. 160. DD

Ecology response 8/30/21: Disposition accepted, pending revisions.

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of the PA have been updated to make the change suggested in the comment. Note, the background value is not used, so this change does not alter any of the simulation results.

DO2-2. Section 2.1.9 (or elsewhere in Section 2.0) - The 200-E-286-Ditch should be discussed along with its association with well corrosion. At least three wells were lost at WMA A-AX due to well corrosion. At the three corroded and decommissioned wells, the corrosion occurred above the water table at (or slightly above) a fine-grained geologic unit (the Cold Creek silt-dominated unit [CCUz]). This unit creates perching conditions for groundwater (percolating downward between the surface and the water table) and greatly increases lateral spreading. The most likely source of the corrosion is chloride-bearing effluent from the 200 East Area powerhouse (284-E Powerhouse) that was discharged to an unlined ditch (200-E-286 Ditch) that traversed the southwest end of what later became the 241-A Tank Farm (Figure 1-2). This ditch was active from 1946 to 1953. The CCUz fine-grained unit and the increased amount of lateral spreading of the chloride-bearing waste water are the subject of the next three comments. JWL

USDOE Disposition 7/9/21

Response: DOE acknowledges that the cause of the casing corrosion seen in local wells provided in this comment has been the subject of a number of recent local investigations and may have some relevance and importance to the recent past and current subsurface conditions in the vicinity of the WMA A-AX area. However, this information is likely to have limited value to the post closure conditions evaluated in this PA analysis.

RPP-ENV-61497 is a post-closure analysis of residual wastes left in tank and ancillary equipment under landfill closure conditions. The simulations include a Cold Creek sit unit referred to as CCUz as detailed in RPP-RPT-60171 Table 3-1. In the geoframework model described by RPP-RPT-60171, the CCUz in the vicinity has a maximum observed thickness in a borehole that is 4.57 m, but the average CCUz thickness in the boreholes used to develop the geoframework model is 1.7 m. This CCUz layer is included in the fate and transport model and if modeling suggested lateral spreading would occur because of this unit under the closed conditions, it would be reflected in the simulation results.

As a post-closure analysis, the simulations assume an engineered barrier that lasts up to 500 years will be placed over the residual waste. Flow in the vadose zone underneath a barrier is significantly different than flow through the vadose zone with anthropogenic recharge from discharges to unlined ditches as discussed in the comment. Lateral spreading beneath a closed WMA should not be expected to be the same as lateral spreading that might result from high volume discharges being impeded by a silt layer.

Ecology Response 9/13/21: Disposition accepted.

DO2-3. Section 2.2.2.1.2, General: The description implies that inventory estimates have a significantly high degree of uncertainty or are essentially unknown, so that one is left to wonder the usefulness of risk estimate results and how they can guide decision making. Also, three significant figures in the inventory estimate Tables seems inconsistent with the precision to which these values are known. SVV

USDOE Disposition 7/9/21
Response: Partially Accepted. The residual waste inventory is highly uncertain. Many of the tanks have not been retrieved and the retrieval strategy is not considered when projecting the new inventory in 360 ft^3 of waste. Prior to seeking closure authorization, the PA will be updated and the inventory for the tank waste and ancillary equipment will be updated with post-retrieval information when it is available. If tanks are not fully retrieved before the regulatory review of the PA for the closure authorization, then revisions to the inventory will be addressed through the PA change control process.

Regarding the usefulness of the inventory, the assessment is a simple scaling of the BBI inventory based on waste volumes, which is why the inventory is provided with 3 significant figures. DOE disagrees with the part of the comment that questions whether such analyses are useful for making decisions. DOE recognizes that there are different professional opinions about the appropriateness of some conceptual and mathematical models and that there is uncertainty in parameter values used in PA simulations. DOE recognizes that models are just models and recognizes that the models must represent the scenario / conditions that need to be evaluated. DOE also recognizes that simulation results are only as good as the information fed to them. However, the PA analyses utilize models that are similar to or more complex than other models used to make decisions at Hanford and throughout the world. PA simulations also provide DOE information about where to prioritize research to help mitigate unwanted impacts to the environment or members of the public in the future. PA simulations also provide DOE with a way to prioritize work when there is insufficient funds or it is impractical to pursue all the actions that might be desirable to minimize the impacts to the environment and the public. DOE believes models, even preliminary ones, serve a purpose to provide decisions makers with enough information to make informed decisions.

Ecology Response 9/28/21: Disposition accepted.

DO2-4. Section 2.2.2.1.2, p. 2-144: Under Waste Inventory Assumptions, item b): clarify if 360 cubic feet is 'per tank'. SVV

USDOE Disposition 7/9/21
Response: Accepted. The text has been added to the native file.

Ecology Response 9/28/21: Disposition accepted.

DO2-5a. Section 2.2.2.1.2, p. 2-145: Under Waste Inventory Assumptions, item f): as described, the concentration estimates for ancillary equipment are highly uncertain, and therefore the analysis uses the average SST concentrations instead, with a rationale that the actual concentrations are likely less than the average SST values. This appears to be an arbitrary substitution for something that is essentially unknown, and does not appear to be defensible. SVV

USDOE Disposition 7/9/21

Response: Partially Accepted. The residual waste inventory in the pipelines is highly uncertain and an initial inventory for these sources must be assumed. This PA clearly identifies the initial inventory as an assumption, which is acceptable by DOE for a preliminary PA. The PA describes the rationale leading to the inventory selection made in the assumption. Alternative inventory cases for specific source terms can be readily evaluated using scaling principles or more directly by re-running the PA with alternative inventories. DOE is required to perform these analyses in accordance with the change management process that will be required by the DOE regulatory body once the PA is no longer preliminary and DOE pursues a closure authorization. Since PAs get updated when new information is learned, such as the collection of new waste samples, the final closure PA performed after all retrieval actions have been completed will utilize the best available inventory estimates for the residual waste. The PA effort may also include special analyses that consider general information related to process knowledge of different waste types and compositions that may havelikely been transported through waste transfer pipelines and ancillary equipment at WMA A-AX as a part of the final evaluation.

Ecology Response 9/28/21: Disposition accepted.

DO2-5b Further, item f) discusses concentrations, but does not address how total ancillary equipment inventory is estimated. SVV

USDOE Disposition 7/9/21

Response: Accepted. A footnote has been added to the native file stating: "RPP-CALC-62319, Residual Waste Source Inventory Term for the Waste Management Area A-AX Performance Assessment Inventory Case 1, calculates the corresponding ancillary equipment inventories by multiplying the concentrations by the ancillary equipment's volume (Retrieval of 90% of the remaining waste is assumed for catch tanks and vaults; residual waste may be contained in as much as 5% of the pipeline volume.)" See also the response to the first part of this comment.

Ecology Response 9/28/21: Disposition accepted.

DO2-6. Section 2.2.2.1.2, p. 2-146, Line 2: Text states, "Also, uranium is treated as a radionuclide and not a chemical for this analysis." As such, clarify why U is included in Table 2-8a. DD

USDOE Disposition 7/9/21

Response: Accepted. A footnote has been added to the native file stating: "Although uranium is treated as a radionuclide in this analysis, the chemical "U-total" is displayed in Table 2 8a because it is reported in RPP-19822 and is included for traceability."

Ecology response 8/30/21: Disposition accepted, pending revisions.

DO3-1. Section 3.1, p. 3-2: Text notes that surface water pathway is omitted. Even though the Columbia River is 11 km away, groundwater plumes from 200 Area contaminants are currentlyapproaching or reaching the river. Clarify why the Columbia River is not a surface water pathway for this PA, when it is reasonable to think that if contaminants reach the point of exposure well, that they will also reach the Columbia River within the 1,000-year time

period. SVV

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been edited to include "Consistent with the PA performed for the WMA in accordance with DOE Order 435.1 this performance assessment is a local-scale evaluation of impacts in the immediate vicinity of the landfill closed facility. Although groundwater flowing below the immediate vicinity of the WMA eventually flows towards and discharges to the Columbia River, the impacts to groundwater are evaluated locally and are below regulatory requirements in the immediate vicinity of the landfill closed WMA A-AX facility. Results of impacts to surface water and potential human and terrestrial/aquatic eco receptors from the residual waste left in the WMA once the groundwater reaches the Columbia River would be expected to be negligible."

Ecology Response 9/28/21: Disposition accepted.

DO3-2. Section 3.1, p. 3-2: Text notes air pathway is negligible since the few radionuclides that can partition into gas phase are present in small quantities. However, groundwater can be brought to the surface for use as irrigation, which can contaminate soil and then enter the air via resuspension. I note later that this pathway is shown in Figure 3-1, so the text discussion should include this 'air' pathway that is shown in the figure. SVV

USDOE Disposition 7/9/21

Response: Clarification. The air pathway scenario only considers exposure pathways where atmospheric transport is the primary transport mechanism between the source and the receptor. Therefore, the proposed exposure pathway discussed in the comment would not be consistent with the air pathway scenario. However, as noted in the paragraph following this one, the groundwater pathway accounts for the pathway described in the comment.

Ecology Response 9/28/21: Will the text make this clarification? It was not clear when I was reviewing the document.

The groundwater scenario includes exposure pathways that result from irrigation with contaminated water. As described in section 3.2.3 (Exposure pathways and scenarios) the all-pathways farmer scenario in the groundwater pathway includes exposure from incidental ingestion of contaminated soil, inhalation of contaminated soil (dust) in the air[2], inhalation of water vaporfrom showering and other household activities, as well as consuming vegetables, animals and animal products contaminated through exposure to contaminants in water or water vapor. Bioaccumulation includes a factor for re-suspended particles that adhere to the agricultural products.

[2] The radionuclide concentrations appliedto the inhaled particulates is equated to the radionuclide concentrations in the irrigated soil. The air born concentrationof particulates in the air accounts for resuspension processes as described in NCRP 129, *Recommended Screening Limits for Contaminant Surface Soil and Review of Factors Relevant to Site-Specific Studies*.

Ecology Response 9/28/21: Is the above paragraph in the document? If so, I accept the response. So long as this info is in the document, I accept the response.

DO3-3. Section 3.1, p. 3-2: Text describes that the nominal case (for dose calculations) is more

conservative than a best estimate. It seems more intuitive that a nominal case would be the best estimate. Why is the nominal case based on assumptions that are less likely valid than a best estimate case? Clarify if a 'best estimate' calculation is carried out, and if it is not, explain why. SVV

USDOE Disposition 7/9/21

Response: Accepted. The nominal or reference case that will be used to compare against compliance standards includes some pessimisms in the performance of the system. Historically PA analyses will evaluate a parameter value to be used in the model and determine whether higher or lower values results in greater impacts to the environment or a member of the public in the future. In the absence of supporting evidence to clearly identify a best-estimate value, an analysis would adopt a pessimistic value for the parameter for a simulation. If the simulation demonstrated that the system would meet all performance requirements with some pessimism in the inputs, it would more than likely meet the performance requirements without the pessimism. A review of the inputs parameters and descriptive text for those parameters will be performed to clearly communicate where pessimistic parameter values are used. If necessary, the PA will be updated to clearly communicate which input parameter values are best-estimates and which parameter values include pessimism.

A best-estimate calculation is not carried out. The PA simulations demonstrate that the closed tank farm meets DOE performance objectives and therefore additional refinement to remove pessimism was not performed because it would not change the conclusion that the closed system complies with DOE requirements.

An example is the assumed failure of the surface barrier. Subject matter experts on barrier performance suggest that a properly constructed barrier can reduce flow into a disposal facility (or closed tank farm) for several hundreds to 1,000s of years. Our PA model assumes the surface barrier performs for 500 years and then instantly loses all performance capability. This step change in performance can cause anomalies in the model results. Better estimates for barrier lifetimes and degradation rates are available but the simulation results indicate that pessimism attributed to the performance of the surface barrier does not result in an unacceptable consequence. Therefore, additional modeling of the performance of the surface barrier is not necessary to demonstrate compliance.

Ecology Response 9/28/21: Disposition accepted.

DO3-4. Section 3.1, p. 3-2: Text explains that 'bounding case' dose calculations are (at least sometimes) based on conditions not considered credible, so that one is left to wonder as to their usefulness in decision making. Clarify why bounding case calculations are not based on credible conditions. SVV

USDOE Disposition 7/9/21

Response: Accepted. Refining the inputs and models relied upon in a PA is a significant effort that must be conducted using available resources and time. Consequently, not all scenarios envisioned for a long-term consequences analysis can be evaluated. One way of limiting the effort to perform a significant amount of model runs evaluating different conditions is to do bounding analyses that demonstrate that if a certain worst-case condition was simulated and met compliance requirements, then any case with a lower loss of performance in that safety function would also meet performance requirements so that those analyses do not need to be

run. With experienced models (and reviewers), this reduced case load can lower the resources necessary to develop the PA without sacrificing quality. If enough model runs are performed to demonstrate an understanding of the system and demonstrate which models and parameters are important to meeting compliance requirements, performing bounding analyses are an efficient approach for identifying which areas of the model do not require refinement to meet the compliance objectives. The native files for next PA revision have been updated to include the following text:

"If the results of the bounding analysis (or "barrier neutralization case") meet all performance requirements for the closed WMA, then it can be concluded that the neutralized safety function may not be important to demonstrating compliance with performance requirements. Therefore, a partial loss of the safety function is not likely to result in an evaluation that does not meet a performance requirement.

As an example, a bounding analysis could neutralize the tank structure and grout placed into the tank to provide structural stability. Consequently, all of the net infiltration above the tank footprint could come into contact with the waste and rapidly transport it away from the tank. If the consequences of this condition meet the performance requirements for a closed system, then any scenario that identifies a process that could introduce a smaller amount of flow into the tank is also not likely to cause the closed system to fail performance requirements. Depending on the resources necessary to perform the simulations, the sensitivity case that only consider a partial loss of the safety function may be performed, but if these additional cases support the claim that the neutralization case is bounding, the results of these simulations may not become part of the technical basis."

Ecology Response 9/28/21: Disposition accepted.

DO3-5. Section 3.2.2.1.6, p. 3-45: Explain the reasoning for the assumption that the entire inventory of a tank is instantly available for release and transport at some point in time (asopposed to a slow degradation of barriers which intuitively seems more likely). SVV

USDOE Disposition 7/9/21
Response: Accepted. A footnote clarifying this statement has been added to the native files for the next PA revision. The statement was not meant to imply that the contaminants were instantly mobilized through transport barriers, but rather to say there is no physical or chemical attribute of the waste that immobilizes the contaminants (except uranium and chromium) preventing them from being transported through the tank floor and into the vadose zone. The footnote states "In the absence of testing with waste from sources in WMA A-AX, the PA model assumes that there is no physical or chemical binding attribute of the waste that prevents contaminants from being transported into the base mat, which the first transport layer in the model that excludes the waste itself.."

Ecology Response 9/28/21: Disposition accepted.

DO3-6. Section 3.2.2.2, p 3-48, Lines 30-31: Clarify that although CH4, TH, and I2 are less likely to be redeposited on the ground surface (and available for ingestion), these gaseous forms maybe inhaled. DD

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of the PA have been updated to "The chemical forms CH_4, TH, and I_2 are considered less likely to be redeposited on the ground surface after release and less likely to be ingested through components of the food chain but still can be inhaled."

Ecology response 8/30/21: Disposition accepted, pending revisions.

DO3-7. Section 3.2.2.2, p 3-48, footnote "4": Re radon, looks like footnote "4" should refer to Section 3.2.2.3 (not 3.2.2.2). DD

USDOE Disposition 7/9/21

Response: Accepted, the Word callout field was not updated prior to PDF creation. The field has been updated in the native file.

Ecology response 8/30/21: Disposition accepted, pending revisions.

DO3-8. Section 3.2.2.4, p 3-54, Table 3-3; p 3-55, Figure 3-16. A recent review of plant rooting depths at Hanford has shown that depths>300 cm are credible, based on observations at other locations (Foxx et al, 1984), effect of plant age on root depth (Klepper et al, 1985; McConnell and Smith, 1977; Clements and Young, 2001), and various sampling limitations (Waugh et al, 1994) (https://setac.onlinelibrary.wiley.com/doi/full/10.1002/ieam.4044). For example, rooting depths up to 914 cm have been reported for sagebrush at Los Alamos, NM (Foxx et al, 1984). Please incorporate this information, re the likelihood of a biotic pathway to transport radionuclides into the shallow zone (0-15 ft) with potential for human and ecological exposure.DD

USDOE Disposition 7/9/21

Response: According to the abstract for Klepper et al. 1985, "The two deepest rooted plants were antelope bitterbrush and sagebrush with average depths of 296 and 200 cm, respectively". This is consistent with the root depth discussion provided in the PA. The abstract for the more recent report by Sample et al, confirms a biologically active zone to depths that will not likely exceed 300 cm. DOE recognizes that other locations with sagebrush ecology may support longer root depths, but site-specific information is preferred for use when available. Therefore, the discussion in the PA that is used to screen out the biotic pathway is still relevant Screening out the biotic pathway because the waste will be deeper than the standard point of compliance (i.e., the residual waste in pipelines, ancillary equipment and SSTs will be more than 15 feet (4.6 m) below the top of the surface barrier) is consistent with the methodology and approaches for related evaluations in a WMA discussed in "Central Plateau Inner Area Cleanup Principles and Parameters" (DOE/RL-2019-46).

Additionally, the barrier design is not finalized. A final design goal will have elements to ensure that barrier thickness is sufficient and biointrusion is mitigated so that the biotic pathway is not a potential source for human and ecological exposure. The final design will consider any new site-specific root depth information that may be discovered during the next 30 years before the final barrier is expected to be built.

Ecology response 8/30/21: Disposition not accepted. Clarify that plant roots can transport

contaminants from subsurface soils (>15 ft depth) to shallow soils (0-15 ft depth) at Hanford, thereby exposing human and ecological receptors to these contaminants. Lovtang et al (2018) refute the claim by Sample et al (2015) that biological activity in soils does not exceed 300 cm (9.8 ft). Furthermore, the Lovtang et al (2018) review supports the MTCA standard POC for soils (15 ft depth) to protect human and ecological receptors.

The USDOE response states a preference for use of site-specific information. Although generally warranted, site-specificity should not ignore sampling limitations nor plant growth/age relationships. Lovtang et al (2018) provide additional detail on these two points (advocating their inclusion, alongside site-specific data):

1) Sampling limitations: "In addition, Fan et al. (2017) found that many studies did not ascertain maximum rooting depth, because 'in most cases, the maximum rooting depth recorded is the depth of the investigation, such as the depth of the trench or the soil core, and they are clearly under-estimates of the true maximum rooting depths.' We found this to hold true for many of the root studies at the Hanford Site, cited by Sample et al. (2015). For example, Waugh et al. (1994), who recorded some of the greatest bitterbrush root depths at Hanford Site, dug 2.5-m (8.2-ft) pits using a backhoe and noted that bitterbrush roots penetrated deeper than this depth (and in one case, much deeper), 'but sloughing sand from the drying walls of the trench inhibited further digging.'"

2) Plant growth/age relationships: "Root depths increase with age, but shrub age was nominally addressed in plant rooting studies at the Hanford Site. Klepper et al (1985) sampled only 4 bitterbrush at 2 locations on Hanford Site; three of these rooted to a depth of 300 cm (9.8 ft) and the fourth to 283 cm (9.3 ft). Only 2 of these bitterbrush were aged, reaching 27 and 25 y; however bitterbrush production might peak at 60 y (McConnell and Smith, 1977), and shrub age in mature stands can average 98 y (Clements and Young, 2001).

DO3-9a. Section 3.2.3, p. 3-56: The PA uses 25 mrem/y as a performance objective. While making no judgement on this value, the Hanford Site generally uses inconsistent performance objectives. Sometimes it is 15 mrem/year, sometimes 25, other times a risk-based objective of1E-4, other times MTCA. Clarify how this PA's performance objective fits into the overall scheme of Hanford's objectives, and

USDOE Disposition 7/9/21

Response: Acknowledged. Since this PA is written to meet the requirements of DOE Order 435.1, it uses 25 mrem/yr for the performance objective for all pathways exposure as called out in DOE Manual 435.1-1, IV. P. (1)(a). The air pathway has a separate standard that is lower than the all-pathways standard to which it contributes; the air pathway performance objective is 10 mrem/yr (DOE M 435.1-1, IV. P. (1)(b)). The radon flux performance objective of 20 pCi/m2/s also comes from DOE M 435.1-1, IV. P. (1)(c). DOE Manual 435.1-1 also sets separate performance measures for acute and chronic exposure following an inadvertent intrusion into the waste. The dose limits are 500 mrem and 100 mrem/yr, respectively (DOE M 435.1-1, IV. P. (2)(h)). Composite Analyses performed in accordance with DOE O 435.1 also have separate standards because the Composite Analysis considers the cumulative contributions from multiple sources, rather than a single source (which is considered an entire tank farm closure area).

MTCA performance objectives are used in the corresponding chemical impacts analysis (RPP-ENV-62206). For many of the remedial investigation reports on site (e.g. DOE/RL-2003-11 Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate l1roup Operable Units) fall under EPA which uses the radiation dose limit for the industrial direct-contact exposure scenario is 15 mrem/year (10 CFR 835 "Radiation Protection for Occupational Workers"). This dose limit is developed for members of the public who are unknowingly exposed to radiation and is approximately equivalent to an excess lifetime cancer risk (ELCR) of 1.0 x 10^{-4}. Therefore, it can be assumed that other documents using different performance objections are written to fulfill different requirements than the current objectives in DOE O 435.1 for a single disposal facility (or tank farm closure area).

In this document, the performance objectives used and their sources are listed in Table ES-1.

Ecology Response 9/28/21: Accept response, but please note that Hanford's inconsistent cleanup objectives (sometimes 15mrem/y, sometimes 25 mrem/y, sometimes 1E-4 risk, etc, shows that there is an inconsistent set of regulations. SVV

DO3-9b explain why Hanford does not use a consistent set of performance objectives. SVV

USDOE Disposition 7/9/21
Response: All recent performance assessments performed in accordance with DOE O 435.1 are compared to the dose and radon release requirements specified in the previous part of the response. Comparisons to other objectives are driven by the regulatory requirements of those analyses.

Ecology Response 9/28/21: Disposition accepted.

DO4-1. Section 4.2.4. Figures 4-21 through 4-26, p. 4-67 – 4-72: According to the text, contaminant groundwater concentrations are attenuated between the fence line and100 m PoCal because contamination from tank sources enters the aquifer with a relatively small footprint and is affected by transverse dispersion, diluting the contamination. The difference in attenuation factors between the two farms is a reflection of the differences in the Darcy flow". The huge attenuation huge attenuation cannot be explained by the above phenomenon (also see figure 5-9). More discussions are required. DG

USDOE Disposition 7/9/21
Response: Clarification. Attenuation in the saturated zone over the 100 m distance from the fence line to the point of calculation 100 m from the fence line reflected for Tc-99 in Figure 4-21b and 4-21c is about a factor of two. Concentrations from 4 pCi/L at the fence line drop to about 2 pCi/L 100 meters downgradient. A similar decrease in concentrations is shown for I-129 in Figure 4-22. Figure 4-17 shows how the Tc-99 plume originating from residual waste is dispersed in the STOMP simulations. The GoldSim model is based on this and honors this result.

Figure 5-9 is not relevant to attenuation between the fence line and 100-m boundary. Figure 5-9 shows that uranium impacts to the groundwater from the pipeline source, which is primarily advection release constrained by solubility limits, is much greater than the release from the

SSTs, which is diffusion release constrained by solubility limits.

Ecology Response 9/22/21: Explanation accepted, pending revision. The document should reflect the discussion provided in the response clarification- especially on how the diffusion release is constrained by the solubility limits.

DO4-2. Section 4.2.7, p. 4-81, lines 2-4: Text states, "The contaminated water is the only sourceof exposure; dose from exposure to contaminated air was calculated separately and has been screened out using the approach described in Section 4.2.5." Refer to Section 5.3 for modeling rationale for "screened out" (as used here). DD

USDOE Disposition 7/9/21

Response: Partially Accept. Section 4.2.5 describes the approach. The sentence in question has been clarified in the native file to read: "The contaminated water is the only source of exposure; dose from exposure to contaminated air was calculated separately and has been screened out using the results of the approach described in Section 4.2.5." The following sentence has been added after that: "The atmospheric pathway screening results are presented in section 5.3."

Ecology response 8/30/21: Disposition accepted, pending revisions.

DO5-1. Section 5.1.2, p. 5-4, text and Figure 5-2: The figure indicates that entire inventory of I-129 in the pipelines releases to the vadose zone in about ten years, and this release starts immediately after closure. Therefore, it would seem these same release rates would be occurring at the present time, as the difference between year 2020 and 2050 seems insignificant in terms of available release mechanisms? In other words, what is preventing those same release rates from happening now? Please discus this. Further, if releases are occurring now, measuring release rates could be used to validate release mechanism models. SVV

USDOE Disposition 7/9/21

Response: Not accepted. In response to "what is preventing those same release rates from happening now", the answer is the integrity of the pipeline itself. The PA is a post-closure analysis. For this analysis, rather than include models to evaluate the corrosion rates and justify of the pipelines, the PA adopts the approach that the integrity of the pipeline is intact up to the time of closure and is instantly compromised at the time of closure and no longer protects the residual waste. There are numerous studies that show waste transfer lines are presently intact (RPP—RPT-49200 Direct Assessment of 241-SY Pipelines SN-285 and SN-286. RPP-RPT-47901, 2010, Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610). The timing of when the pipelines corrode to the point that they no longer contain the waste was not evaluated for the PA, because in this post-closure analysis assuming that time of initiation and complete corrosion is the time of closure allows DOE to evaluate the condition that should lead to the highest impact to groundwater and members of the public in the future. Under this scenario, the waste inventory in the pipelines is not reduced by past releases, which maximizes the inventory in this source term when the simulated releases begin to occur. Evaluating evidence of present day corrosion on pipelines, such as net infiltration getting into the pipelines, leading to a present day release is outside the scope of the PA, which is a post-closure analysis.

Ecology Response 9/28/21: If the pipelines are intact now at the present time, it seems they will also be intact in 2050 at closure. However, given that I-129 has a long half-life, there is no need to predict when the pipelines might fail in the future in order to account for radioactive decay. If the contaminant was a short-lived nuclide, such as Co-60, then the timing would matter. So, I accept the response.

DO5-2. Section 5.2.1, Tables 5-1 and 5-2: It would be useful to include the peak total concentration from both tank farms and the EPA MCL concentrations in these tables. Further, why is there no equivalent table for U-238? SVV

USDOE Disposition 7/9/21

Response: Accepted. Tables 5-1 and 5-2 can be updated to include the appropriate groundwater protection measure, such as the EPA MCL. There is no specific reason for excluding a table of peak values for ^{238}U. The peak values are reported in Table 5-3, but this format does not include the time of the peak (10,000 years). Adding a new table for U-238 to identify the peaks that are shown in Figures 5-8 and 5-9 will be considered, but the peaks are very low relative to the EPA MCL of 30 µg/L. The highest concentration shown in these two figures is approximately 1E-7 pCi/L. When converted 1E-07 pCi/L (3E-7 µg/L) of ^{238}U is 8 orders of magnitude below the MCL. The text will also be updated to report the peak values.

Ecology Response 9/28/21: If U-238 remains omitted, there should be an explanation, as in the response above, in the document.

Regarding the comment to provide the peak release from both tank farms, the peak release of the co-mingled plume from sources in both tank farms is approximately equal to the peak release from the A-tank Farm. The ^{99}Tc plumes for each farm generated by a STOMP model are illustrated in Figure 4-17. A flow path directly below the center of A104 and A105 has the highest down gradient concentration at the fence line or 100-meter boundary. This is the flow path yielding the highest peak concentration from A-farm. The saturated zone flow directions are aligned such that the primary direction of flow is nearly parallel to the relative positions of the tank farms. Consequently, the plume from AX farm sources has limited (if any) overlap with the flow path leading to the highest down gradient concentration from A-Farm sources by the time the contaminants reach the WMA fence line or 100-meter down gradient boundary. With limited comingling of the plumes along the flow path that leads to the highest down gradient concentration from sources in either farm, the comingled peak is approximately equal to the peak from A-farm sources.

Ecology Response 9/28/21: The above paragraph is a satisfactory explanation, and should be in the document to avoid anyone wondering the same as my comment.

DO5-3a. Section 5.3, general: It could be useful to state the air emission standards (mrem/year)here for reference. SVV

USDOE Disposition 7/9/21

Response: Accepted. The DOE O 435.1 atmospheric pathway performance objective has been added to this section in the native file.

DO5-3b. Further, when quoting dose results in the text, units of mrem/year (rather than

mrem) would be clearer. SVV

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next revision have been updated to correct the reported units to mrem/yr.

Ecology Response 9/28/21: Disposition accepted.

DO5-4. Section 5.3, p. 5-12, lines 21-27: As described in Section 3.2.2.2 (and from an exposure potential), clarify here in Section 5.3 that the more relevant form of H-3 is tritiated water (TOH)vapor (not H_2 gas) with plant uptake and the more relevant form of I-129 is hydrogen iodide (HI) (not I_2 gas) with redeposition to the ground surface. DD

USDOE Disposition 7/9/21
Response: The text will be reviewed and clarified as necessary. The bounding analysis for the air pathway will be reviewed to ensure that an alternate conceptual model that includes deposition with subsequent bioaccumulation does not yield a greater dose result than the screening analysis considered.

Ecology response 8/30/21: Disposition accepted, pending revisions. Thank you for checking on redeposition/bioaccumulation.

DO5-5. Section 5.4.1, p 5-18, Table 5-7. Please add the radon flux performance objective (20 $pCi/m^2/sec$) to this table as a footnote. DD

USDOE Disposition 7/9/21
Response: Accepted. The footnote has been added to the native file.

Ecology response 8/30/21: Disposition accepted, pending revisions.

DO5-6. Section 5.5.1, p. 5-19: Define 'groundwater dose conversion factor' .SVV

USDOE Disposition 7/9/21
Response: Accept. The sentence was clarified to read "The linear scaling factor between the two is called the groundwater dose conversion factor." Additionally this sentence was added after it: "A groundwater concentration for a radionuclide can be multiplied by the corresponding groundwater dose conversion factor to obtain the dose."

Ecology Response 9/28/21: Disposition accepted, pending revision.

DO6-1. Section 6.1.4.2, p. 6-12: The uncertainty in residual inventory estimates is likely to be large, and likely to be a significant contributor to overall uncertainty. Yet, due to the preliminary state of retrieval and lack of data, this component of uncertainty is not considered.Discuss how the omission of this uncertainty component will impact the uncertainty analysis. SVV

USDOE Disposition 7/9/21
Response: Accepted. Post-retrieval inventories are uncertain. Future PAs will include inventory

uncertainty in the analysis as retrievals are completed and better estimates of residual inventories and the uncertainty in these estimates are quantified through sampling. In this preliminary PA, inventory uncertainty was not ignored, it was considered using sensitivity studies that included a case where the initial inventory assumed no retrievals. This one-change sensitivity case complied with DOE performance objectives.

Omitting inventory uncertainty is not likely to affect the information learned from the uncertainty analysis. The key radionuclides that impact the groundwater and a member of the public in the future are ^{79}Se, ^{99}Tc, ^{129}I, and for some realizations, uranium isotopes. It is not likely that the omission of inventory uncertainty masks the importance of other radionuclides because transport through the natural system is the primary mechanism that controls whether a radionuclide reaches the groundwater and becomes a key radionuclide that impacts the groundwater and a member of the public in the future. Uncertainty in the sorption coefficients and net infiltration rate that control transport through the vadose zone was included in the uncertainty analysis and most other radionuclides still did not reach the groundwater to cause a future impact.

Therefore, the only thing that omitting inventory uncertainty can affect is the magnitude of the peak groundwater concentration / dose and relative importance of the key radionuclides. For ^{79}Se, ^{99}Tc, ^{129}I it can be shown that the transport models used in the PA have linear effects on the peak groundwater concentrations (RPP-CALC-63176, Integrated Disposal Facility Risk Budget Tool Analysis) so that a change in inventory for ^{79}Se, ^{99}Tc, ^{129}I has a proportional change in the peak groundwater concentration from ^{79}Se, ^{99}Tc, ^{129}I. For uranium, release from the residual waste is governed by a solubility limit so the impact to groundwater is not a linear effect of inventory. For uranium isotopes that are solubility-controlled in the tanks, inventory uncertainty would alter the duration of release from the tanks, but not the magnitude of the release rate. The uranium release rate is constrained by the pore water concentrations that are constrained by solubility limits.

The importance analysis (RPP-ENV-61497 Section 6.1.6.3) demonstrates that the key uncertainties governing uncertainty in dose are the Darcy flux in the saturated zone and net infiltration rate followed by the K_d for Tc in the grout (RPP-ENV-61497 Table 6-9). Whether another uncertain parameter becomes more significant in the importance analysis when inventory uncertainty is accounted will be evaluated in a future revision of the PA after estimates of inventory uncertainty are developed for post-retrieval conditions. It is noted, that the WMA C PA did include inventory uncertainty in the probabilistic analysis. The key uncertainties governing uncertainty in the dose at WMA C were the same as though identified in the WMA A-AX PA importance analysis despite the inclusion of inventory uncertainty in the WMA C PA and omission in the WMA A-AX PA.

Ecology Response 9/28/21: Disposition accepted.

DO6-2. Section 6.1.6.1, p. 6-32: Discuss the reason for assuming the peak total dose is normallydistributed. Discuss how the 95% confidence interval might change if the distribution is not normal. SVV

USDOE Disposition 7/9/21

Response: Accepted. The performance metric used to test statistical stability is that the 95% confidence interval for the mean of the peak doses does not change with increased number of

realizations. The test of the 95%-confidence interval using Equation 6-1 requires that the uncertainty in variable being evaluated be normally distributed. If the uncertainty in the variable is not normally distributed, then an alternate method to develop the 95% confidence interval would need to be used instead of Equation 6-1. One such technique is the bootstrap confidence interval. Developing bootstrap confidence intervals can be done with statistical software and the discussion of the process would be included in the PA if that approach were adopted.

The potential consequence of using Equation 6-1 when the underlying distribution is not normally distributed is that the selected number of realizations to perform the uncertainty analysis may be insufficient. However, comparison of confidence intervals is a numerical comparison of what is depicted in RPP-ENV-61497 Figures 6-11 and 6-12. From these two figures it is demonstrated that the time history for the mean annualdose from WMA A-AX sources is practically the same whether 300 or 1,000 realizations are used in the uncertainty analysis. The small differences between the mean dose time histories for the 300 and 1000 realization cases does not suggest that using more than three times as many realizations would yield a result that exceeds DOE performance objectives.

Ecology Response 9/28/21: DOE accepted my comment, which asks for a discussion, but it is not clear from the response what DOE is going to do. Is the above text in their response going to be added to the document?

DO6-3. Section 6.1.6.1, p. 6-33, Table 6-8: In Section 5, the nominal case dose assessment for the total contributions in A Farm results in a median peak dose of 0.3 mrem/y (considering out to 10,000 years). Here, in Table 6-8, the results of the uncertainty analysis show a range of peak dose from essentially zero to about 3 mrem/y, with a standard deviation of about 0.3 mrem/y. Given the lack of sample and other data, and uncertainties in model parameter valuesand how systems will behave over thousands of years, it seems improbable that the range of possible dose outcomes only spans 3 mrem/y. It appears to imply a level of knowledge that seems improbable. Is this analysis saying that the uncertainty in dose is so small that values greater than 10 mrem/y (and comparable to the dose limit) are not possible, especially since uncertainty in residual tank inventory appears to not be included in the analysis? SVV

USDOE Disposition 7/9/21

Response: Whether the uncertainty analysis is adequate for its intended purpose is up for the regulators to decide. The intended purpose is to support the case for a closure authorization that requires a reasonable expectation that the closed WMA will meet DOE's performance requirements. A DOE LFRG review team has provided comments to revise some of the uncertainty distributions based on their knowledge of statistical modeling approaches. The next revision of the PA will address the DOE LFRG review team comments.

The uncertainty in the peak dose will be determined by the uncertainty in the parameters that most significantly influence the uncertainty in the peak dose. When the uncertainty in only a few parameters control the uncertainty in the peak dose[3], the range of values used for those parameters will determine the range of uncertainty in the dose results.

[3] Identifying the parameters that have the greatest influence on the uncertainty in the peak dose is performed using the importance analysis discussed in RPP-ENV-61497 Section 6.1.6.3.

Although the uncertainty analysis can be viewed as only having a difference in 3 mrem/yr, another viewpoint is that the minimum peak dose (0.0015 mrem/yr) and the maximum peak dose (3.6 mrem/yr) differ by a factor of 2,400. Therefore, the uncertainty in the input parameters contributes at least three orders of magnitude of uncertainty in the peak dose result.

The four parameters that include uncertainty in the PA model that contribute the most to the uncertainty in the peak dose are (in order): the saturated zone Darcy flux, the net infiltration rate, the distribution coefficient for ^{99}Tc on grout in the base mat, and the diffusion coefficient for grout in the base mat. The ratio of the minimum and maximum values for these distributions are: 24, 10.4, 2, and 33, respectively. The order of influence means that the uncertainty in the saturated zone Darcy flux (min:max = 24) influences the range of peak dose results more than the net infiltration rate (min:max = 10.4), which influences the uncertainty in the peak dose more than the distribution coefficient for ^{99}Tc on grout in the base mat (min:max = 2), which influences the uncertainty in the peak dose more than the effective diffusivity through the grout base mat (min:max = 33). When combined and sampled independently, the uncertainty in these distributions contribute to a minimum and maximum peak dose that are more than three orders of magnitude different.

These results are very consistent with results of the uncertainty analysis done for the WMA C PA (RPP-ENV-58782) which did account for uncertainty in post-closure residual inventories based on post-retrieval sampling from 10 retrieved tanks.

Adding inventory uncertainty would increase the relative difference between the minimum and maximum peak doses.

Ecology Response 9/28/21: Disposition accepted.

DO6-4. Section 6.1.7, p. 6-70: The text should mention that uncertainty in residual tankinventory is not included in the uncertainty analysis. SVV

USDOE Disposition 7/9/21
Response: This statement is included further on in Section 6.1.7 on page 6-72 lines 24 and 25. The statement is also made previously in the PA on page 6-9 lines 17-22, page 6-43 line 16.

Ecology Response 9/28/21: Disposition accepted.

DO6-5. Section 6.2.3, p. 6-85: Inventory sensitivity case 1 is intended to represent the maximum possible inventory based on current knowledge of the waste. But it appears there is very little 'knowledge' of waste, as there is very little sample data, and rather the 'knowledge' of waste is based on modeling estimates which likely have a high degree of uncertainty.
Discuss the uncertainty in the current BBI and HTWOS based estimates and how this would propagate to the sensitivity case 1 results. SVV

USDOE Disposition 7/9/21
Response: Section 6.1.4 (page 6-9 lines 18 – 22) report that peak groundwater concentrations and radionuclide doses are proportional to the initial inventory for radionuclides that do not have a solubility limit (all radionuclides included in the PA model except uranium isotopes and

the decay products of these isotopes that only reach the groundwater because they are transported to the groundwater as a uranium isotope that decays immediately before reaching the groundwater or while it is in the groundwater). Therefore, scaling the radionuclide concentration in groundwaterfrom INV1 can be used to propagate inventory uncertainty to the primary dose contributors in INV1 provided that post-retrieval inventory uncertainty are developed.

The peak dose from all source in A-Farm in INV1 is 2.74 mrem/yr, ^{99}Tc contributes nearly 100% of the dose at the time of the peak. Therefore, the peak dose would scale linearly with changes in ^{99}Tc inventory until inventory changes for ^{79}Se, ^{129}I or a uranium isotope cause these radionuclides to contribute more to the peak dose than they do in case INV1. In case INVI the peak dose from ^{79}Se is 0.065 mrem/yr and the peak dose from ^{129}I is 0.11 mrem/yr but the doses from all radionuclides except ^{99}Tc are practically 0 mrem/yr (less than 7E-10 mrem/yr) at the time of the peak ^{99}Tc dose.

NOTE: Uncertainty in BBI estimates is included in RPP-ENV-61497 Section 2.2.2.1.2 under the subheading "Current Inventory Estimates in Single-Shell Tanks". Radionuclide-specific uncertainty estimates for tank waste were also estimated in an analysis developed for the IDF PA (RPP-RPT-59958 Rev 1A). That analysis (documented in RPP-CALC-62058 Rev 1 Appendix B) investigated inventory uncertainty in all tanks, not just those in WMA A-AX. The analysis quantified the inventory uncertainty using BBI records for sampled tanks that have sample measurements with a standard deviation because the sample analysis was performed in duplicate (or triplicate). The analysis was not limited to waste characteristic of residual waste left in tanks. It included liquid supernatant samples, which tend to have lower sample-to-sample variably driving the overall uncertainty lower than if only saltcake and sludge samples were considered.

Ecology Response 9/28/21: Disposition accepted.

DO7-1. Section 7.0, p 7-1, Lines 39-40: Text states, "Table 7-2 presents parameters common to all intruder scenarios." Table 7-2 presents BBI (not parameters). Please fix. DD

USDOE Disposition 7/9/21
Response: Accepted the sentence has been deleted from the native file since it is a duplicate call-out.

Ecology response 8/30/21: Disposition accepted, pending revision

DO7-2. Section 7.0, p. 7-2, Table 7-1: Explain why meat consumption is omitted from the Chronic Rural Pasture exposure, forexample from livestock on the pasture. SVV

USDOE Disposition 7/9/21
Response: The rural pasture scenario represents a small-scale operation where drill cuttings are spread over an area of 5,000 m2 (1.2 acres). This amount of land is sufficient to sustain a cow (and its calf) assuming the entire area is available for grazing, as a result only milk consumption is evaluated as a complete exposure route. The total area is insufficient for sustaining beef cattle and their forage, therefore beef consumption was not included as an exposure route for the rural pasture scenario.

Ecology Response 9/28/21: Is the above response either already in the document, or if not, will it be added? If so, then accept response.

DO7-3. Section 7.0, p. 7-2, and p, 7-31, Table 7-7: Intrusion calculations are carried out at 100 years for drilling through the pipelines, but earlier in the document, it was described that pipeline inventories are essentially unknown, and are based on an average of estimated tank waste inventories (which seems arbitrary). The results of this intrusion scenario appear to bearbitrary since the source term, which contributes to the concentration of drill cuttings, is notknown. Discuss the level of knowledge of the source term for this scenario, and how it contributes to uncertainty. SVV

USDOE Disposition 7/9/21

Response: The regulating body for the intruder calculations (DOE's LFRG) has reviewed the assumptions used in the intruder analysis and accepted using current tank waste composition as an approximation for the inventory estimate. The inventoryis developed from the Best Basis Inventory, which is developed using DOEs best knowledge of what has been sent to the tanks and withdrawn from the tanks corroborated by tank samples. DOE believes it is reasonable to base residual waste estimates for the pipelines based on the residual waste left in the tanks after waste was transferred into and out of the tanks using those pipelines. Although the current tank estimates are based on retrieving waste to its current levels, flushing the lines after each transfer was assumed to have the same effect of pipeline residual waste compositions even though flushing the lines after a transfer is more likely to be effective for cleaning the lines than sluicing the tanks after years of waste aging in the interim stabilized tanks.

There is no pipeline sampling data available to quantify uncertainty for the composition of the residual pipeline waste. The assumptions in the intruder scenario reflects DOEs best approximation. DOE will consider expanding the intruder analysis to evaluate how waste transferred through the pipelines in the past might impact an intruder. However, this analysis was done for WMA C with P2 waste, which is the most dominant waste transferred in the WMA A-AX pipelines, and concluded that the intruder dose into P2 waste would likely exceed DOE limits depending on the amount of waste intercepted. In lieu of this, DOE will consider calculating radionuclide concentrations in the waste that would cause a dose to a hypothetical intruder that exceeds DOE's performance measures in DOE Manual 435.1-1. This type of analysis was conducted to set WAC limits for the Hanford IDF, as described in RPP-CALC-61254 R3 Sections 3.3 and 6.2.

Ecology Response 9/28/21: I had asked for a discussion, which can be brief, of the level of knowledge of the source term for this scenario, and it is unclear if the DOE's response accepts that they will include such discussion.

DO7-4. Section 7.4.1, p. 7-31, Table 7-7: Please specify the retrieval status (pre vs. post-retrieval) and inventory source (HTWOS vs. BBI) for tanks in this table (in relation to information provided in Sections 1.8 and 2.2.2.1.2). DD

USDOE Disposition 7/9/21

Response: Accepted. The tanks' retrieval statuses are described in a footnote saying: "As of

April 2021, only tank 241-AX-102 has started retrieval operations. The tank inventories in this table represent projected post-retrieval inventories except for tanks 241-A-104 and 241-A-105 which are assumed to remain unretrieved at closure". A new column has been added indicating the inventory source for each tank and pipeline.

Ecology response 8/30/21: Disposition accepted, pending revision

DO7-5. Section 7.4.2.1. p. 7-38. The Intruder Analysis indicates that further analysis of pipelineresiduals may be warranted. The pipeline inventory is highly uncertain. JWY

USDOE Disposition 7/9/21
Response: Comment acknowledged. The PA already states that additional work to quantify the uncertainty in the pipeline inventory is warranted and will be evaluated.

Ecology Response 9/15/21: Disposition accepted.

DO7-6. Section 7.4.2.2 Figure 7-20 (a-d), 7-21 (a-d), p. 7-48 – 7-49: The inclusion of the average values on Figure 7-20(a-d) and Figure 7-21(a-d) only provide a qualitative indication of the model's representation of the vadose zone moisture profile. Since we have plenty of moisture data, a quantitative and statistical (including multiple realizations) approaches would provide better understanding of the vadose zone flow and transport. DG

USDOE Disposition 7/9/21
Response: There seems to be a problem with this comment. The beginning mentions intruder figures in 7.4.2.2, but then appears to paste and modify text from Appendix D. A comment from the DOE LFRG Review Team is very similar to this comment. That comment and the response are discussed in Appendix D page D-19 to D-24.

Ecology Response 9/22/21: A discussion is requested to understand the significance/ implications of the moisture profiles observed in A-AX and other tank farms (e.g. C).

DO9-1. Section 9.1.3, p 9-3, lines 12-13. Please provide Ecology with the DOE-0431 memorandum. JWY

USDOE Disposition 7/9/21
Response: DOE-0431 has been cleared for public release and can be provided.

Ecology Response 9/15/21: Disposition accepted.

DO9-2. Section 9.1.5, p. 9-5, Table 9-3: Noting that the 5th - 95th percentile range of the meanprobabilistic analysis dose, 0.14 - 0.92 mrem/y seems incredulously small relative to the lack ofknowledge associated with this analysis. It implies a level of knowledge that appears improbable. SVV

USDOE Disposition 7/9/21
Response: Comment acknowledged. There doesn't appear to be any actionable item in the comment. Whether the uncertainty analysis is adequate for its intended purpose is up for the regulators to decide. The intended purpose is to support the case for a closure authorization that requires a reasonable expectation that the closed WMA will meet DOE's performance

requirements. DOE's LFRG review team has provided comments to revise some of the uncertainty distributions based on their knowledge of statistical modeling approaches. The next revision of the PA will address the DOE LFRG review team comments and may expand the number of parameters treated with uncertainty (such as uncertainty and exposure factors) if the information is available. Note: uncertainty in exposure factors is available, but if included will likely drive the dose lower since the PA tends to use 95th-percentile values for exposure factors.

Ecology Response 9/28/21: Disposition accepted.

DO9-3. Section 9.1.5, p. 9-5, Table 9-3 and lines 34-37 through lines 1-6, p. 9-6: It seems implausible that regulatory performance objectives will be met over the entire duration to 10,000 years. A summation of all uncertainties would need to be calculated before coming tothis gross conclusion. JWY

USDOE Disposition 7/9/21
Response: Comment acknowledged. The conclusions in Section 9.1.5 are based on the analyses that have been performed and documented in this performance assessment. Regarding uncertainties, DOE's LFRG review team has provided comments to revise some of the uncertainty distributions based on their knowledge of statistical modeling approaches. The next revision of the PA will address the DOE LFRG review team comments and may expand the number of parameters treated with uncertainty (such as uncertainty and exposure factors) if the information is available.

Ecology Response 9/15/21: Disposition accepted.

DO9-4. Section 9.3, p. 9-6, line 42: Text states, "The current PA is based on inventory estimates prior to retrieval from WMA A-AX." However, clarify that the base case (INV0) assumes and evaluates projected inventory after retrieval, except tanks 241-A-104 and 241-A-105 which are assumed not to be retrieved. DD

USDOE Disposition 7/9/21
Response: Accepted. The native file for the next revision has had these sentences added: "These base case inventory estimates are the projected inventory after retrieval. The base case assumes that tanks A-104 and A-105 will not be retrieved."

Ecology response 8/30/21: Disposition accepted, pending revision

DOA1. Section A.8.2, p. A-16: Use of the information and studies of WMA C may not be appropriate for a similar evaluation at WMA A-AX. The CCUz silt unit at WMA A-AX is not present at WMA C. The two sites are not comparable in terms of heterogeneity. The CCUz at WMA A-AX is up to 35-ft thick over the waste management area. There is nothing comparable at WMA C and potential for lateral spreading of contaminants in the vadose zone is greater. JWL

USDOE Disposition 7/9/21
Response: RPP-ENV-61497 is a post-closure analysis of tank and ancillary equipment residuals.

The simulations include the CCUz as detailed in RPP-RPT-60171 Table 3-1. In the geoframework model described by RPP-RPT-60171, the CCUz in the vicinity has a maximum observed thickness in a borehole that is 4.57 m, but the average CCUz thickness in the boreholes used to develop the geoframework model is 1.7 m. This CCUz layer is included in the fate and transport model and if modeling suggested lateral spreading would occur because of this unit under the closed conditions, it would be reflected in the simulation results. Additional modeling performed for WMA C evaluations on heterogeneity and the impacts of low permeability layers concluded that the presence of heterogeneity and low permeability layers that would promote lateral spreading reduced peak concentrations in the groundwater.

While the hydrogeologic framework at WMA A-AX is slightly different than hydrogeologic conditions at WMA C, both of these areas share some common characteristics that make some of the previous work done at WMA C very applicable to conditions at WMA A-AX. In particular, both areas contain thick sequences of sand-dominated hydrostratigraphic units that containthe presence of thin fine-grained layers that have elevated moisture contents relative to the overall average moisture contents found in the sand facies of these units. The effect of these thin fine-grained units with elevated moisture content on flow and transport through the vadose zone was the focus of a number of detailed analysis at WMA C that are very relevant to WMA A-AX. Although the WMA C subsurface does not include a several-foot-thick layer of CCUz above the water table, the preliminary WMA A-AX models do include the CCUz layer as an EHM based on the findings from the work performed for WMA C.

Conceptual models that explicitly represented these types of vadose zone heterogeneities in major HSUs beneath WMA C were evaluated in much detail and sought to understand the potential effects of heterogeneities on flow and contaminant transport at WMA C that included:

- *A summary of previous work by PNNL documented in PNNL-24740, Alternative Conceptual Models of the Subsurface at WMA C;*
- *A summary of previous work by WRPS, PNNL, and INTERA, Inc. (INTERA) that is in the process of being documented in RPP-RPT-61239, Multiple Lines of Evidence and Modeling Results for Heterogeneous Alternative Conceptual Models of the Subsurface at Waste Management Area C, in preparation; and*
- *A summary of recent work by WRPS and INTERA completed at the request of Ecology and documented in Section 5 and Appendix B of RPP-RPT-59197.*

The last body of work where we worked very closely with Ecology to address their specific areas of concerns related to the effect of subsurface heterogeneities on flow and transport is particularly noteworthy. This scope involved multiple simulations of a cross-sectional model that evaluated the effect of thin fine-grained high moisture layers based in interpretations by the Nez Perce in the sand-dominated sequence on a leak from tank C-105. This specific past leak consisted of a 5-year release from 1963 to 1968 of a 20,500 gal waste volume containing ~10 Ci of ^{99}Tc to the upper part of the vadose zone between the tank 241-C-104 and tank C-105. All aspects of the conceptual model including the selection of hydraulic properties for the fine-grained units were specified by Ecology staff.

General observations from the range of simulation cases examined in this generic study of the heterogeneity at WMA C with Ecology staff were as follows.

- *The movement of the center of mass of the simulated plumes was generally vertically downward below the source for all simulations, including those that incorporated the alternative thin fine-grained units.*
- *All simulations that incorporated alternative heterogeneity produced additional plume spreading over what was produced in simulation using the EHM model(s). The spreading resulted in a broadening of the fringes of the plume, resulting in a wider region of low concentration, but lower peak concentrations associated with the center of mass of the plume.*
- *The EHM representation of the vadose zone generally produced higher peak mass flux and an earlier occurrence of peak fluxes at the water table compared to all analyses incorporating additional alternative interpretation ofheterogeneity.*

The results produced in this modeling evaluation of heterogeneity with Ecology was generally consistent with results produced in the other two studies. The other studies were based on examining the effect of other alternative conceptual models of subsurface heterogeneities of both past leaks and tank residuals using more detailed three-dimensional modeling. In these other studies, the EHM representation of the vadose zone generally produced the least amount of plume spreading and higher peak mass flux at the water table compared to all other analyses incorporating additional alternative interpretation of heterogeneity.

It is DOE's position that the detailed analyses of the effect of subsurface heterogeneity performed at WMA C is very applicable to conditions at WMA A-AX and that a detailed reanalysis of the effects of these types of heterogeneities in the vadose zone for hydrogeologic conditions at WMA A-AX is not warranted at this time and would serve only to confirm the general results of the modeling studies that were produced at WMA C.

As a post-closure analysis, the simulations assume an engineered barrier that lasts up to 500 years will be placed over the residual waste. Flow in the vadose zone underneath a barrier is significantly different than flow through the vadose zone without a barrier. Lateral spreading beneath a closed WMA should not be expected to be the same as lateral spreading that might result from higher volume flows being impeded by a silt layer.

Ecology Response 9/13/21: Disposition accepted.

DOA2. Section A.8.2, page A-16: This assumption does not take into account the thicker and more extensive CCUz unit at WMA A-AX. Conclusions that were made on the basis of data fromWMA C that does not have a thick aquitard (or at times an aquiclude) may not be appropriate. Lateral spreading may be much more pronounced than assumed from studies at WMA C. JWL

USDOE Disposition 7/9/21
Response: See response to comment #DOA1.

Ecology Response 9/13/21: Disposition accepted.

DOA3. Section A.8.6, p. A-18: "Lateral spreading in the vadose zone is minimal" may not be a valid assumption. See comments 1, 2, and 3. Furthermore, the corrosion of the 3 wells at WMA (that had to be replaced) occurred at the level of the CCUz in each well, most likely due to chloride spreading from the 200-E-286 Ditch. Corrosion is still occurring at WMA A-AX wells and has spread at least as far as 299-E27-14. Well 288-E27-14 is more than 200 meters from the location of the former location of the 200-E-286 Ditch. So, we know that lateral

spreading at WMA A-AX has not been limited to 100 meters (or the boundary of the WMA). JWL

USDOE Disposition 7/9/21
Response: See response to comment #DOA1.

Ecology Response 9/13/21: Disposition accepted.

Review Comment Record

Ecology Comments

Document: RPP-ENV-62206, Rev. 0, *Analysis of Post-Closure Groundwater Impacts from Hazardous Chemicals in Residual Wastes in Tanks and Ancillary Equipment at Waste Management Area A-AX at the Hanford Site, Southeast Washington*

Date: March 2021

Reviewers: DD, DG, TH, JWL, BR, MBS, JWY

HCRG1. General: Nature and scope of this TPA document. It is clear from the scope of this document, this PA document should not be treated as a secondary document. It is a "primary" TPA document as this document is supposed to involve a lot of decision making (ref.1.1.2, page 1-9, etc.) which justifies this document as primary not as preliminary document. For example, it stated that "The primary purposes of the preliminary PA are to 1) establish an efficient modeling framework; 2) provide an initial evaluation of impacts to groundwater, air, and inadvertent intruder from estimated tank residual waste prior to retrieval of waste from SSTs; 3) support other HFFACO Appendix I retrieval documents requiring risk assessments (TWRWPs [HFFACO Appendix I Section 2.1.3] and RDRs [HFFACO Appendix I Section 2.1.7]); and 4) support decisions on whether or not to forego the use of a third tank retrieval technology. Etc. Etc. which justify to treat this document as primary. However, Ecology's comments, should be considered as preliminary since it didn't address the intended purpose of a number of decision making description/analysis. Ecology will have more thorough analysis of this document as we move through our discussion of these preliminary comments and other associated documents as per appendix I and related topics such as the past leak analysis, modeling issues of calibration, uncertainty analysis, risk assessments, etc. DG

USDOE Disposition 7/9/21

Response: Not accepted. In letter 21-TF-000593 dated February 23, 2021, DOE responded to Ecology's position that RPP-ENV-62206 should be a primary document. In that letter DOE stated their position that "Neither RPP-ENV-62206 nor RPP-ENV-61497 are HFFACO primary documents". The letter further states: "As set forth in Section 9.1 of the HFFACO Action Plan, primary documents are identified in Table 9-1 and are "those which represent the final documentation of key data and reflect decisions on how to proceed." Since neither RPP-ENV-62206 nor RPP-ENV-61497 represent final documentation of key data or reflect decisions on how to proceed, characterizing either as a TPA primary document is inconsistent with Section 9.1 of the HFFACO Action Plan."

Ecology Response 9/22/21: Disposition not accepted. Ecology considers the IPA documents the main effort to demonstrate that human health and the environment will be protected by assumed closure conditions at the WMAs. Protecting human health and the environment is required for closure under WAC 173-340-610(2)(a)(ii).

HCRG2. General: p. 1-32, Section 1.4.2, Closure: A critical component of the closure decision is using the corrective action process to document in the Tier 2 (WMA specific) closure plan, based on the RFI/CMS and Appendix I performance assessment, that not all contaminated soils can be practicably removed or decontaminated in order to replace the clean closure requirements in WAC 173-303-640(8)(a) and WAC 173-303-610(2)(b) with the landfill closure requirements in WAC 173-303-665(6) and WAC 173-303-645. USDOE will need to remove any additional waste from ancillary equipment or remediate contaminated soil if those actions are required to demonstrate compliance with the applicable closure performance standard. TH

USDOE Disposition 7/9/21
Response: Not accepted. The comment identifies a closure action. The closure action cannot be addressed through RPP-ENV-62206.

Ecology Response 7/29/21: Understood; however, Ecology's position that the IPA will be used to inform closure decisions stands. Disposition accepted.

HCRG3. General: One of the lessons learned from the WMA-C PA was the problem of fragmenting the PA into multiple documents. This same fragmented approach has been adopted for WMA-A-AX. Acknowledging complexities of predicting exposures to human and ecological receptors over 10000 years from multiple source terms, this administrative fragmentation impedes proper integration of risk (at relevant time and space domains) from various source terms (e.g., tank residuals vs. past leaks present in soil). Fragmentation also inefficiently repeats common information (i.e., much of the text in several sections, e.g., site and facility characteristics, implementation of models). This issue should be re-visited for future WMA PAs. DD, MBS

USDOE Disposition 7/9/21
Response: DOE intends to prepare a single document for the HFFACO Appendix I PA for WMA A-AX. The document will contain multiple volumes that segregate material addressed by different regulations. This approach should reduce some of the redundancy referred to in the comment and is similar to the approach taken by DOE/EIS-0391, Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC&WM EIS).
Additional Response: This issue is being discussed in Holistic Negotiations between DOE and Ecology. This comment cannot be addressed in this document at this time.

Ecology Response 8/30/21: Disposition not accepted. Because the fragmented approach described for the WMA A-AX PA appears similar to the one taken for WMA C, it is difficult to consider WMA A-AX any different. Ecology had provided USDOE a proposed outline for the structure of the WMA A-AX, although this was largely ignored. A more integrated approach will continue to be a goal for future WMA PAs. DD

HCGR4. General: Ecology requests PA calculations and graphs that show the sum of impacts of all contaminants (including radionuclides) on groundwater, over the time period from closure

through the 10,000 year time period, from all WMA A-AX source terms combined, in particular including contamination in the vadose zone from past leaks, residuals in pipelines and ancillary equipment, and tank residuals. MBS

USDOE Disposition 7/9/21
Response: Not accepted. The scope of RPP-ENV-62206 is a post-closure fate and transport evaluation of dangerous chemicals in the waste residuals left in SSTs, ancillary equipment, and pipelines in WMA A-AX after the WMA is closed and covered with an engineered surface barrier. The requested analysis for a cumulative evaluation of tank residuals, ancillary equipment residuals, pipeline residuals together with contamination in the vadose zone from past leaks is outside the scope of RPP-ENV-62206.
DOE will consider the development of a Synopsis document that provides a summary of the impacts of all the sources at WMA A-AX described in the different IPA volumes.

Ecology Response 9/21/21: Disposition not accepted. The disposition does not commit to a synopsis document, so Ecology requests that the summary graphs, illustrating the impacts to ground water from all the sources at WMA A-AX, should be provided in this document.

HCRG5. General: Ecology requests tables and/or and graphs that show contaminant concentrations (all hazardous contaminants), total cancer risks (nonradioactive carcinogens plus radionuclides), and chemical hazard indices, in groundwater over the time period from closure through 10,000 y. We request this for all WMA A-AX source terms combined, including contamination in the vadose zone from past leaks, residuals in pipelines and ancillary equipment, and tank residuals. BR

USDOE Disposition 7/9/21
Response: Not accepted. The scope of RPP-ENV-62206 is a post-closure fate and transport evaluation of dangerous chemicals in the waste residuals left in SSTs, ancillary equipment, and pipelines in WMA A-AX after the WMA is closed under landfill conditions and covered with an engineered surface barrier. The requested analysis for a cumulative evaluation of tank residuals, ancillary equipment residuals, pipeline residuals together with contamination in the vadose zone from past leaks is outside the scope of RPP-ENV-62206.
DOE will consider the development of a Synopsis document that provides a summary of the impacts of all the sources at WMA A-AX described in the different IPA volumes.

Ecology Response 9/14/21: Disposition not accepted. The disposition does not commit to a synopsis document, so our request remains for the graphs to be provided in this document, or the risk assessment component of the IPA.

HCRG6. General: p. 1-46: For the purposes of this volume of the PA, it assumes the A-104 and A-105 will not be retrieved. While for the purposes of a PA that could make sense, Ecology disagrees with that assumption in terms of the retrieval requirements for A Farm (reference CD if needed). Include an analysis where retrieval of waste is consistent with Appendix H goals. TH

USDOE Disposition 7/9/21

Response: A sensitivity case that reduces A-104 and A-105 residual waste volume to 360 ft^3 can be performed for the next revision to RPP-ENV-62206. The sensitivity case will show an equivalent reduction in projected impacts to groundwater from chemicals that are not solubility controlled. Uranium and chromium are the only chemicals with a solubility control in the analyses documented in RPP-ENV-62206; therefore, the impact to groundwater from uranium and chromium would likely be unchanged by the sensitivity case. This sensitivity case will be considered for the next revision to RPP-ENV-62206.

Ecology Response 9/27/21: Disposition not accepted. Ecology would like USDOE to apply the retrieval assumptions consistently. If USDOE has sensitivity cases that meets their requirements, Ecology will support USDOE's decision-making needs. Ecology will anticipate a revision to this document for the Appendix I PA, with the primary evaluation case assuming retrieval, and USDOE can provide a sensitivity case for no retrieval.

HCRG7. General: The performance assessment includes waste sites that are in CERCLA operable units. Please include text to describe the interface between this performance assessment and the decision making for those CERCLA OUs. For example, the 241-A-151 Diversion Box and the 241-A-302A catch tank are also included in the Part B DST permit application and the 200-CP-1 RI/FS work plan and the information provided in those documents does not align with the information provided in the PA. TH

USDOE Disposition 7/9/21

Response: WRPS technical staff have reviewed the comments Ecology provided on the 200-CP-1 RI-FS Workplan that pertain to WRPS work products, including the preliminary PA and RCRA Impacts Analysis. In response to those comments, WRPS is recommending that sources not pertaining to WMA A-AX be excluded in future revisions of the PA and RCRA Impacts Analysis to minimize the potential for misalignment of information and duplicative modeling by different contractors for different purposes. The next revision of the PA will exclude locations that are outside the boundary of A Farm and AX Farm as defined in the Draft Rev. 9 RCRA permit, plus the 241-A-302B Catch Tank, consistent with letter 21-TF-000513 (https://pdw.hanford.gov/document/AR-08918). NOTE: In the preliminary PA only the inventory from 241-A-151 diversion boxes and 241-A-302A catch tank were included in a release model for all ancillary equipment. The releases from these sources were not separately modeled . Future revisions of the PA will simulate releases from ancillary equipment separately, but these two sources would be excluded.

Ecology Response 7/26/21: Disposition accepted.

HCRG8. General. Ecology will use the requirements in WAC 173-340-700 through -760, including WAC 173-340-720 and-730 values for groundwater and surface water, and possibly other defensible lines of evidence to evaluate releases from this RCRA TSD (past and future) to

environmental media and determine the need for action in those media. See WAC 173-303-64620(4)(g). BR

USDOE Disposition 7/9/21

Response: Partially Accept. This analysis examines the potential impacts of residual waste in the tanks on groundwater. Impacts from contaminated soil will be examined in an upcoming document. To address CULs for groundwater, this analysis will use CULs from CLARC (Feb 2021 edition) to compare to the calculated groundwater concentrations.

Ecology Response 9/14/21: Disposition partially accepted. The comment was made to indicate some of the criteria Ecology will use to determine remedy protectiveness. We will use the criteria listed in the comment also to determine if the tank and ancillary equipment residual waste, once released in the future from the tanks and ancillary equipment, will exceed acceptable concentrations in the soil with regard to protection of groundwater and surface water, and human and ecological direct contact for any shallow ancillary equipment (such as pipelines).

HCRG9. General. Need for a DQO process with participation of stakeholders, tribal nation: Similar to the C tank Farm and the TC-WMA EIS, the a formal DQO process involving stakeholders, tribal nations is required to get input on the following:

- An accepted scoping of the document with safety functions
- Specific sensitivity case analysis
- Acceptance of the FEPs
- Risk assessment scenarios. DG

USDOE Disposition 7/9/21

Response: This response assumes the DQO process mentioned in the comment is referring to the scoping process that was initiated in 2009 in support of the development of the WMA C HFFACO Appendix I PA process and not the DQO process that has been used to support characterization efforts and sampling and analysis planning with RCRA Facility Investigation/Corrective Measures Studies done in SST WMAs.
These WMA C PA scoping sessions were not required but were set up so that DOE and Ecology could learn from each other and come together on what was necessary to address all of the analysis requirements for an HFFACO Appendix I PA. These scoping meetings helped define the scope for each analysis required in the Appendix I PA, and assisted each organization understand the criteria and requirements of each of the analyses.
These scoping sessions were very valuable to establishing the types of analyses that would be required to support requirements found in Appendix I of the HFFACO Action Plan that would support the tank closure process. From the WMA C scoping sessions, a set of analyses (i.e. DOE Order 435.1 PA, RCRA Closure Analysis, Risk Assessment of Contaminated Soils and Vadose Zone Sediments and the Analysis of Past Leaks) were established for WMA C to meet the Appendix I requirements. It is DOE's position that the necessary impact analyses of past releases and residual wastes established for

WMA C IPA and the subsequent agreements implemented in the Central Plateau Inner Area Principles and Parameters provide the current basis for HFFACCO Appendix IPA analysis framework that DOE will be using at other SST PAs.
DOE has no plans to use further detailed scoping sessions such as those used for WMA C to revisit the HFFACO Appendix I analysis framework for other SST WMAs.

Ecology Response 9/23/21: Disposition not accepted. Ecology requests a discussion about this issue.

HCGR10. General: A-AX Tank Farm PA vs C Tank Farm: It is a major change in the approach used for this PA compared to C Tank Farm. The following points are noted to address and concur by the regulators and the USDOE:

- It took both the agencies to go through a thorough DQO process for 3 years involving stakeholders, tribal nations and the public to come up with an acceptable process of analysis to address a number of important issues. Ecology, believes most of the issues/problems are more or less same and some need more rigorous process to analyze how to move forward. A detailed DQO process is therefore required to be followed. DG

USDOE Disposition 7/9/21
Response: See response to comment #HCRG9

Ecology Response 9/23/21: See Ecology's response to the disposition for comment HCRG9.

- No computational process should be avoided just because "those process models were computationally intensive, often taking hundreds of hours to evaluate a complete suite of sources for multiple radionuclides.". Ecology made a number of comments and well as discussions were held to address these issues. Those comments are not highlighted here but communicated in many ways through letters, workshops, please look at those

USDOE Disposition 7/9/21
Response: Partially accepted. The text will be revised. Process modeling with STOMP is computationally intensive. However, process modeling with STOMP wasn't avoided because of its intensity alone. This will be clarified in the next revisions of the RPP-ENV-61497 and RPP-ENV-62202. There is no requirement for a PA or RCRA Impacts Analysis to use a computationally intensive model. This should be especially true when analyses are performed to show that abstraction models can produce similar results; the computational efficiency of a system of abstraction models allows for more analyses to be performed leading to better understanding of the closed WMA system as a whole. DOE's oversight body for PA's, the LFRG, convened a review team of modeling experts to review the modeling approach adopted in the preliminary PA. The experts saw value in using abstraction models to evaluate different alternatives, and approved the approach to move from preliminary PA to a PA for closure authorization. The LFRG review team did make some suggestions

where abstractions could be improved. These recommendations are being incorporated into the next revision of the PA.
In addition, both the PAs for WMA C and IDF demonstrate the capability of a 1-D fate and transport model to replicate the behavior of the more detailed 3-D flow and transport model performed with STOMP. STOMP process modeling is still necessary and was performed to develop the flow fields (time histories of Darcy flux and moisture content at different depths in the vadose zone) that are used in the 1-D vadose zone abstraction. Transport of ^{99}Tc, ^{129}I129 and U was performed using STOMP process models to help develop the vadose and saturated zone model abstractions. The 1-D vadose zone abstracted was adjusted until the 1-D output gave results that were consistent with the 3-D process model for these radionuclides.
Similarly, the Darcy flux and dispersion in the 1-D saturated zone model are compared to 3-D process models to ensure the 1-D model produces a similar result. The use of a 1-D abstraction in lieu of 3-D finite difference models is justified because flow in the vadose zone under post-closure conditions becomes a unit gradient solution. Net infiltration rates are the same as the recharge rates to the saturated zone. This has been demonstrated with an equivalent homogenous medium representation to be more pessimistic than a heterogeneous model that may not be as well represented by a 1-D abstraction. In the saturated zone, hydraulic gradients are so large that dilution from upgradient water entering the plume is the main effect of the saturated zone. Dispersion occurs but the travel distance and transport times are small enough that a 1-D representation honors the behavior observed in the 3-D process model pretty well. Please see also the response to comment HCR4-1.

Ecology Response 9/23/21: Disposition partially accepted, pending revisions. Ecology requests a meeting to discuss this issue.

- Need a detailed comparison with the TC-WM EIS. There are big differences of the approaches used which need to be evaluated/compared before moving forward. Other issues will come when we engage our discussions in these issues. The current approach is not acceptable without complete understanding of a number of these issues. DG

USDOE Disposition 7/9/21
Response: Not accepted. There are three main reasons why DOE believes a detailed comparison to the TC & WM EIS is not necessary. The Summary Analysis for WMA C compared the modeling approaches between the WMA C PA and the TC & WM EIS. The STOMP modeling performed as the basis for the 1-D abstractions used in the preliminary WMA A-AX PA and RCRA Impacts Analysis are similar, adopting the same modeling approach; modeling approach comparison is the same as described in the WMA C Summary Analysis.
Secondly, the TC & WM EIS did not publish isolated impacts from WMA A-AX at any location downgradient of the WMA. Since the preliminary PA and RCRA Impacts Analysis only include sources within or nearby WMA A-AX, there are no results that can be directly compared to results published in the TC & WM EIS.
Lastly, DOE's memorandum for site contractor to use the TC & WM EIS as a modeling

starting point has been rescinded so that DOE no longer requires modeling contractors to start from the TC & WM EIS models to develop PAs.

Ecology Response 9/23/21: Disposition not accepted. Ecology requests a meeting to discuss this issue.

HCRG11. General: Closure Steps: As per the document/executive summary, 3 closure steps are identified (ref. P ES-1, last paragraph):

- SST waste retrieval,
- filling the tanks with grout for stabilization, and
- surface cover barrier placement.

The closure steps should include any corrective actions for soil as well as groundwater and associated activities. Explain how it will be addressed. DG

USDOE Disposition 7/9/21

Response: Accepted. The text listing the steps will be expanded to say: "78 FR 75913, "Record of Decision: Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington," the Record of Decision (ROD) for TC&WM EIS states "The tanks will be grouted and contaminated soils may be removed. The SSTs will be landfill closed, which means they will be stabilized, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care." This means that closure of the individual SSTs and WMA A-AX in its entirety occurs in three major steps: 1) SST waste retrieval, 2) filling the tanks with grout for stabilization, and 3) surface cover barrier placement. Additionally, remedial actions, such as retrieval of residual waste from the ancillary equipment, may be necessary to close the ancillary equipment in the WMA." (Precedent for this response set in RPP-RPT-58806)

Ecology Response 9/23/21: Disposition not accepted. Please remove the text in the disposition that refers to precedent from RPP-RPT-58806. This document has not been accepted by Ecology at this time, and it would need to be in order to set any precedent. Ecology requests a meeting to discuss this issue.

HCRG12. General: (ref. p. ES-5; 4th bullet): Provide a general description what is meant by the "bounding" inventories?" DG

USDOE Disposition 7/9/21

Response: Accepted. Bullet text will be changed to say: "Bounding inventories for tanks and ancillary equipment. These inventories use current Best Basis Inventory values, which are from the unretrieved tanks, and as such represent an upper inventory bound."

Ecology Response 9/23/21: Disposition accepted, pending revision.

How you addressed the uncertainties in defining the bounding conditions not only on inventories, but also all other aspects of uncertainties (e.g. modeling: System vs process, parametric, etc.).

USDOE Disposition 7/9/21

Response: The uncertainty analysis involves the identification of sensitivity cases and alternative models or assumptions for the safety functions identified in Table B-1. The uncertainty analysis includes a set of analyses that explore the implications of the loss of safety functions, while at the same time exploring the implications of aggregated features,events, or processes (FEPs) that might affect the safety function in similar ways. The uncertainty analysis examines what happens in the impacts analysis model when the safety function behaves differently than expected, is degraded compared to a nominal set of conceptual models and assumptions, or is lost entirely. In general, the complete loss of a safety function represents a bounding condition.

Ecology Response 9/23/21: Ecology requests a meeting to discuss this issue.

Also, it is not clear how a single modeling framework of abstracted system level model can integrate all aspects/components of the PA in spite of their limitations that are often characterized by coarser numerical discretization, lower dimensionality. Appropriate technical discussion should be reflected in several applicable chapters dealing with these issues. DG

USDOE Disposition 7/9/21

Response: Partially accepted. DOE will review the discussion already in the document for clarity. The preliminary WMA A-AX PA and closely related RCRA Impacts Analysis use detailed 3-D finite difference flow and transport simulations and a system model that uses abstractions with lower dimensionality (1-D vs. 3-D). The 3-D finite difference model is developed in STOMP and simulates vadose zone and saturated zone flow and transport. Transport is limited to ^{99}Tc and ^{129}I. The output of these models is used directly in the system model or used as a comparison point for developing a system model abstraction that replicates the behavior. The comparisons are made in RPP-ENV-61497 Sections 4.2.3.3, 4.2.4, 6.1.4.5, and 6.1.5. The comparisons in RPP-ENV-61497 Section 4.2.4 show that the system model replicates the STOMP model simulations in both trend and magnitude. This is largely because both process and system model use the same source term, and transport through the natural system below the tanks and ancillary equipment (vadose and saturated zones) in the system model is simulated using flow fields (the time evolution of Darcy flux and moisture content in the vadose zone at different depths) that are direct output of the more detailed 3-D finite difference models. In RPP-ENV-62206, similar discussion is presented in Sections 4.1, 4.2.2, 4.2.3, and 4.2.4. Section 4.2.4 shows comparison figures for nitrate that are analogous to those shown for ^{99}Tc and ^{129}I in RPP-ENV-61497.

Ecology Response 9/23/21: Partially accept, pending revision. Ecology requests a meeting to discuss this issue.

HCRG13. General. Some support documents only recently became available for our reference (ex. RPP-RPT-60101). We may have significant future comments that stem from the support documents that were not available until late in our review (or after our review). BR

USDOE Disposition 7/9/21

Response: Developing the HAFFACO Appendix I PA is an iterative process. RPP-ENV-62206 Rev 0 is the first iteration of the development process. As communicated in letter 21-TF-000593 from DOE to Ecology in response to Ecology letter , "Given the preliminary nature of these secondary documents, an Ecology review that includes its review of the supporting documents as suggested is unnecessary and premature at this time. Please see Section 9.2.3 of the HFFACO Action Plan, which clarifies that a lead regulatory agency has the option to provide comments or take no action; therefore, a review by Ecology is not mandatory for secondary documents".

Ecology response 9/14/21: The comment was a statement; it appears that USDOE's disposition was a statement; and this response is also a statement. Ecology requested this preliminary performance assessment to inform tank retrieval decisions. We reviewed it so that we could determine if it was possible to use it to inform tank retrieval decisions. Also, reviewing it gave us an opportunity to see and comment on the methodology used and give feedback early in the IPA development process. We consider Appendix IPA documents to be primary TPA documents. These preliminary WMA A-AX IPA documents are preliminary because they precede completion of tank retrieval, tank residual sampling, and soil sampling. We expect that sample data will be used in subsequent revisions of these documents. We will repeat comments that we are making here in our reviews of subsequent revisions of the WMA A-AX IPA documents unless the issues are resolved in subsequent revisions. We will also make additional comments as necessary as we gain further information from sample results and all of the pertinent support documents that become available.

HCRG14. General: Ecology requests that the 17 WHO dioxin-like polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) be evaluated in groundwater, due to detects of several PCDD/PCDF congeners in groundwater underlying WMA A-AX. DD and BR

USDOE Disposition 7/9/21

*Response: Not accepted. COPCs will be consistent with the DQO for tank closure activities (RPP-23403). A review of the TWINS database and BBI does not provide an inventory for any of the 17 WHO . dioxin-like polychlorinated dibenzo-p- dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). [**Dioxins:** 2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, and OCDD. **Furans:** 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF]. Therefore, the fate and transport of these chemicals from residual waste in WMA A-AX cannot be evaluated. Furthermore, the CLARC Master spreadsheet from February 2021 lists a K_d for hexaclorodibenzo-p-dioxin, mixture to be 695 ml/g (cell CD340) and a K_d for TCDD;*

2,3,7,8-(LOW ORGANIC) (DIOXIN) to be 249 ml/g (cell CD554). Contaminants with such high K_d values that could be leached from residual waste in closed SSTs and ancillary equipment covered by an engineered surface barrier would not reach the groundwater in 10,000 years. Contaminants with values greater than 1 ml/g do not reach the groundwater in 10,000 years.

Ecology Response 8/30/21: Disposition not accepted. The absence of PCDD/PCDF inventory in TWINS and BBI does not confirm the absence of these contaminants in residual waste from tanks/ancillary equipment at WMA A-AX. Furthermore, despite Kd data, dioxins have been detected in groundwater. Our request is to evaluate the 17 WHO PCDDs/PCDFs in soil and groundwater underlying WMA A-AX (not in residual waste), due to previous detects of several congeners in groundwater. Dioxin-like congeners are important in risk assessment (e.g., groundwater ingestion).

HCRG15. General: Please clarify in the Executive Summary that this document evaluates groundwater impacts (via leaching) of waste contaminants in tank residuals and ancillary equipment without considering current groundwater contamination. DD

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next document revision have been updated. The second paragraph of the Executive Summary has been edited to include "The analysis is a post-closure analysis of residuals left in the single shell tanks, ancillary equipment and pipelines. The analysis start period is after the WMA is closed and covered with an engineered barrier. The analysis does not evaluate the cumulative impact with existing soil contamination or comingling with existing groundwater contamination."

Ecology Response 8/30/21: Disposition accepted, pending revision.

HCRES1. p. ES-1. Please include text provided by Ecology explaining how this preliminary document is considered a primary TPA document for review, as well as comment resolution, to meet TPA requirements. DG

USDOE Disposition 7/9/21
Response: Not accepted. In letter 21-TF-000593 dated February 23, 2021, DOE responded to Ecology's position that RPP-ENV-62206 should be a primary document. In that letter DOE stated their position that "Neither RPP-ENV-62206 nor RPP-ENV-61497 are HFFACO primary documents". The letter further states: "As set forth in Section 9.1 of the HFFACO Action Plan, primary documents are identified in Table 9-1 and are "those which represent the final documentation of key data and reflect decisions on how to proceed." Since neither RPP -ENV-62206 nor RPP-ENV-61497 represent final documentation of key data or reflect decisions on how to proceed, characterizing either as a TPA primary document is inconsistent with Section 9.1 of the HFFACO Action Plan."

Ecology Response 9/22/21: Disposition not accepted. Ecology considers the IPA documents the main effort to demonstrate that human health and the environment will be protected by assumed closure conditions at the WMAs. Protecting human health and the environment is required for closure under WAC 173-340-610(2)(a)(ii).

HCRES2. p. ES-1, Paragraph 2: “This impacts analysis is required by the State of Washington for closing U.S. Department of Energy (DOE)-operated facilities that will manage hazardous chemical and dangerous waste generated during departmental activities as low-level waste.” Please explain the use of the term “as low-level waste” in this context. Is the analysis to make a low-level waste management decision included in this volume of the PA? TH

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision have been modified as follows: "Under DOE O 435.1, a PA is an analysis of a low-level radioactive waste disposal facility performance, used to address post-closure protection of human health. Appendix I of the HFFACO Action Plan contains language that broadens the scope of a "performance assessment." The Appendix I PA is comprised of four parts examining the impacts of tank residuals, contaminated tank farm sediments and past leaks. Taken together, these four parts provide the data and analyses needed to make waste management decisions."

Ecology Response 7/26/21: Disposition accepted, pending revision.

HCRES3. p. ES-1, Paragraph 4: “Closure of the individual SSTs and WMA A-AX in its entirety occurs in three major steps: 1) SST waste retrieval, 2) filling the tanks with grout for stabilization, and 3) surface cover barrier placement.” Please include “removal or remedial actions” as a major step, as there may be remedial or removal actions required for soils and ancillary equipment to maximize protection of human health and the environment. TH

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision have been modified near the text receiving the comment as follows: "Additionally, remedial actions, such as retrieval of residual waste from the ancillary equipment, may be necessary to close the ancillary equipment in the WMA. "

The text listing the steps will also be expanded to say: "78 FR 75913, “Record of Decision: Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington,” the Record of Decision (ROD) for TC&WM EIS states “The tanks will be grouted and contaminated soils may be removed. The SSTs will be landfill closed, which means they will be stabilized, and an engineered modified RCRA Subtitle C barrier put in place followed by post-closure care.” This means that Closure of the individual SSTs and WMA A-AX in its entirety occurs in three major steps: 1) SST waste retrieval, 2) filling the tanks with grout for stabilization, and 3) surface cover barrier placement. Additionally, remedial actions, suchas retrieval of residual waste from the ancillary equipment, may be necessary to close the ancillary equipment in the WMA." (italicized text incorporated from previous response)

Ecology Response 7/26/21: Disposition accepted.

HCRES4. P. ES-5, Lines 39-42. Note that in addition to sensitivity analyses (i.e., base case vs. alternative cases, mainly related to waste mobility), please add that assumed receptor exposure (e.g., scenarios, pathways, parameters) also contributes uncertainty to post-closure performance of WMA A-AX (e.g., residential tap water scenario [groundwater ingestion/inhalation] vs. agricultural scenario [including irrigated crop food ingestion]). DD

USDOE Disposition 7/9/21
Response: Not accepted. Receptor exposure uncertainties do not alter the performance of the disposal system. We agree that receptor exposure uncertainties impact the magnitude of the consequence following an exposure to residual waste left in the SSTs and ancillary equipment. But receptor uncertainties do not the affect the evolution of performance for the closed system.

Ecology Response 8/30/21: Partially accepted. However, receptor exposure scenarios impact not only the "magnitude of the consequence following an exposure to residual waste left in the SSTs and ancillary equipment" but also the types of exposures evaluated, thereby influencing how performance of the closed WMA is assessed, along with interpretation and conclusions drawn.

HCRES5. p. ES-7, Line 43. Because this document applies only to nonrad chemicals, delete external exposure. DD

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next revision have been modified as suggested.

Ecology Response 8/30/21: Disposition accepted, pending revision.

HCRES6. P. ES-8, Figure ES-5; Section 3.1, p 3-2, Figure 3-1. DD
USDOE divided this comment into 5 parts (a-e):

a. These figures describe an EPA tap water scenario and MTCA groundwater pathway, although they exclude direct contact risk from ancillary equipment above 15 ft depth (e.g., pipelines) for human and ecological receptors. This exposure pathway from ancillary equipment should be evaluated for human ingestion, inhalation, and dermal contact, as well as protection of groundwater via leaching and direct contact exposure to ecological receptors (e.g., plants, soil biota, birds, mammals). Humans and wildlife may also be exposed via contaminated food consumption in this shallow zone (<15 ft depth).

USDOE Disposition 7/9/21

Response: Not accepted. This assessment is focused on a groundwater impact analysis of hazardous chemicals from residual wastes left in tanks, ancillary equipment, and pipelines at WMA A-AX under landfill-closure conditions. The WMA closure conditions would include filling tanks and some ancillary equipment with grout. Both the residual wastes left in grout –filled SSTs, ancillary equipment, and pipelines would then be covered by a RCRA-compliant engineered surface barrier that would limit any direct contact with residual wastes. Although the design for the surface barrier is not completed, the barrier is expected to cover multiple WMAs in the vicinity of WMA A-AX and the top of the cover is expected to be more than 15 ft above the WMA A-AX pipelines. Therefore, in the closed WMA the pipelines will be more than 15 ft below the surface of the engineered cover. Impacts of direct contact with contaminated soil and vadose zone sediments prior to barrier placement will be evaluated in a risk assessment related to those sources in support of the RFI/CMS process at WMA A-AX.

Ecology Response 8/30/21: Partially accepted. Clarify in Figure ES-5 and Figure 3-1 that the depicted CEM is under post-closure conditions and that pre-closure conditions will be evaluated in the forthcoming BRA for WMA-A-AX, as well as in the associated RFI/CMS at WMA A-AX. These documents (for current and potential threats) should include soil direct contact pathways for human and ecological receptors, as well as protection of groundwater via leaching and exposure to groundwater via ingestion and other uses (e.g., showering).

b. In addition, it should be acknowledged that a human intrusion scenario could transport residual tank waste to the surface, where human and ecological receptors could be exposed.

USDOE Disposition 7/9/21
Response: Not accepted. Intrusion for the scenarios mentioned (e.g., drilling and construction) is not in the RCRA regulatory framework for landfill closure conditions being analyzed. Impacts to human and ecological receptors will be examined in a risk assessment of contaminated soils and vadose zone sediments that will be undertaken in support of the RFI/CMS process at WMA A-AX.

Ecology Response 8/30/21: Disposition accepted.

c. Clarify how the tap water (resident) scenario meets RCRA closure requirements, given that this scenario is not specified in RCRA. Include all relevant exposure pathways which address RCRA.

USDOE Disposition 7/9/21
Response: Accepted. RCRA Closure and Post-Closure requirements are described in WAC 173-303-610; closure requirements under this section are defined in WAC 173-303-601(2) and 2(i).These sections refer to WAC 173-340-700 through 173-340-760 as follows: "For soils, groundwater, surface water, and air, the numeric cleanup levels calculated using unrestricted use exposure assumptions according to the Model Toxics Control Act Regulations, chapter 173-340 WAC as of the effective date or hereafter

amended. Primarily, these will be numeric cleanup levels calculated according to MTCA Method B, although MTCA Method A may be used as appropriate, see WAC 173-340-700 through 173-340-760, excluding WAC 173-340-745; " WAC 173-340-700 through 173-340-760 describe the procedures used to calculate cleanup levels and WAC 173-340-708 specifically describes the human health risk assessment procedures. The inputs and assumptions used for the tap water scenario follows the procedural requirements described in WAC 173-340-708 thus meeting RCRA closure requirements and WAC 173-340.
Text has been added to clarify that the tap water scenario used to estimate cancer risks and non-cancer hazards are sufficient to meet TPA and RCRA closure requirements for this landfill analysis of residual waste impacts. In addition to the tap water (residential) scenario, groundwater concentrations are compared to DWS and MTCA groundwater cleanup levels to meet RCRA closure requirements (see Section 6.2.3, last paragraph in the Revision 1 update). The results of the tap water risk assessment and comparisons of peak groundwater concentrations to MTCA groundwater cleanup levels and DWS are presented in Chapter 5.

Ecology Response 8/30/21: Disposition accepted, pending revisions. Also, the next to last sentence of the USDOE response refers to "Section 6.2.3, last paragraph in the Revision 1 update." Is this a revised version of RPP-ENV-62206 (Rev. 0) that we have not yet seen?

d. In particular, the Dangerous Waste (DW) Regulations (which conform with RCRA and implement RCRA in Washington) require CULs for environmental media (e.g., soil, groundwater, surface water, air), based on MTCA Method B (unrestricted land use), to meet closure performance standards (WAC 173-303-610[2][b][i]).

Response: Partially Accepted. This analysis examines the potential impacts of residual waste in the tanks on groundwater. Impacts from contaminated soil and vadose zone sediments will be examined in a risk assessment of those sources that will be undertaken in support of the RFI/CMS process at WMA A-AX.
To address CULs for groundwater, this analysis will use CULs from CLARC (Feb 2021 edition) to compare to the calculated groundwater concentrations. Text will be added in this section stating that groundwater CULs from CLARC will be used for comparison to predicted groundwater concentrations.

Ecology Response 8/30/21: Disposition partially accepted, pending revisions. Ecology is expecting a forthcoming BRA for WMA-A-AX, as well as pre-closure analysis in the associated RFI/CMS at WMA A-AX. These documents (for current and potential threats) should include soil direct contact pathways for human and ecological receptors, as well as protection of groundwater via leaching and exposure to groundwater via ingestion and other uses (e.g., showering).

e. Re groundwater, evaluations of both direct ingestion (WAC 173-340-720) and soil protective of groundwater (WAC 173-340-747) are required. DD

Response: Partially accepted. The site-specific model used in this evaluation is not being used to establish cleanup levels for soil concentrations protective of groundwater at WMA A-AX. Evaluation of contaminated soil with soil cleanup levels for direct contact and groundwater protection will be examined in a risk assessment of contaminated soils and vadose zone sediments that will be undertaken in support of the RFI/CMS process at WMA A-AX.
Groundwater clean up levels from CLARC (Feb 2021 edition) are based on equations and exposure assumptions presented in 2013 MTCA WAC 173-340-720, "Groundwater Cleanup Standards" and will be used to compare to the calculated groundwater concentrations. Text will be added in this section stating that groundwater CULs from CLARC will be used for comparison to predicted groundwater concentrations.

Ecology Response 8/30/21: Disposition partially accepted, pending revisions. Ecology is expecting a forthcoming BRA for WMA-A-AX, as well as pre-closure analysis in the associated RFI/CMS at WMA A-AX that will include groundwater ingestion and protection of groundwater.

HCRES7. P. ES-8, Lines 16-18; Section 3.1, p 3-1, Lines 40-44. Although surface water is not present near WMA A-AX, groundwater flows into the river. Therefore, please clarify that groundwater below WMA A-AX must protect surface water and river sediment, because WMA A-AX lies directly over 200-PO-1 which, in turn, flows into the Columbia River. DD

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next revision of this document have been edited to include ""Per DOE Order 435.1 this performance assessment is a local-scale evaluation of impacts in the immediate vicinity of the landfill closed facility. Although groundwater flowing below the immediate vicinity of the WMA eventually flows towards and discharges to the Columbia River, the impacts to groundwater are evaluated locally and are below regulatory requirements in the immediate vicinity of the landfill closed WMA A-AX facility. Results of impacts to surface water and potential human and terrestrial/aquatic eco receptors from the residual waste left in the WMA once the groundwater reaches the Columbia River would be expected to be negligible."

Ecology response 8/30/21: Disposition not accepted. Rather than expecting impacts to receptors (associated with surface water [Columbia River]) to be negligible, demonstrate this with modeling.

HCRES8. p. ES-8, Paragraph 1: "The surface water pathway is not a possible exposure pathway for the disposal facility because surface water is not present near WMA A-AX, and is too limited on the Hanford Site Central Plateau in quantity to be used domestically." Please clarify whether the groundwater underlying A-AX abuts surface water. TH

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next revision of this document have been revised to acknowledge that "Per DOE Order 435.1 this performance assessment is a local-scale evaluation of impacts in the immediate vicinity of the landfill closed facility.

Although groundwater flowing below the immediate vicinity of the WMA eventually flows towards and discharges to the Columbia River, the impacts to groundwater are evaluated locally and are below regulatory requirements in the immediate vicinity of the landfill closed WMA A-AX facility. Results of impacts to surface water and potential human and terrestrial/aquatic eco receptors from the residual waste left in the WMA once the groundwater reaches the Columbia River would be expected to be negligible."

Ecology Response 7/26/21: Disposition not accepted. Please revise "The surface water pathway is not a possible exposure pathway for the disposal facility because surface water is not present near WMA A-AX, and is too limited on the Hanford Site Central Plateau in quantity to be used domestically", to 'Any releases to the PO-1 operable unit groundwater, and ultimately surface water, from WMA A-AX will be considered for remedial action at the source and/or in the groundwater.'

HCRES9. p. ES-8, Paragraph 3: "To evaluate protection of water resources, peak predicted hazardous chemical and dangerous waste constituent concentrations in groundwater are compared to available Federal and State drinking water standards." Please modify the end of this sentence to state "Federal drinking water standards and state groundwater cleanup levels". TH

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been edited to include "To evaluate protection of water resources, peak predicted hazardous chemical and dangerous waste constituent concentrations in groundwater are compared to available Federal and State maximum contaminant levels and to the 2013 MTCA Method B groundwater cleanup levels."

Ecology Response 7/26/21: Disposition accepted.

HCRES10. p. ES-8 and ES-9. For the hazardous waste concentration limits in groundwater (and tap water) two standards are cited, MTCA in WAC 173-340-720 (p. ES-8, line 8) and drinking water (MCLs) in WAC 246-290-310 (p. ES-9, line 40). The appropriate standard is for groundwater under MTCA Method B in WAC 173-340-720. However, the MCLs are cited in 11 other places in the document. They include the following:

p. 1-39, Table 1-3
p. 5-3, Section 5-2, paragraph 2
p. 5-9, Table 5-1
p. 5-10, Table 5-2
p. 8-1, Section 8.0, second bullet
p. 8-2, Section 8.1, second bullet on line 11, line 16, and line 29
p. 8-4, Section 8.1.2, line 13
p. 8-6, Tables 8-3 and 8-4. JWL

USDOE Disposition 7/9/21

Response: Accepted. The Feb 2021 Cleanup Levels and Risk Calculation (CLARC) master spreadsheet was retrieved from https://ecology.wa.gov/Regulations-Permits/Guidancetechnical-assistance/Contamination-clean-up-tools/CLARC/Data-tables on May 3, 2021. A comparison was made using the values from the worksheet "GW Method A, B, & ARARs" columns P (Method A), Q (Method B Noncancer), R (Method B Cancer), T (Federal MCL), and U (State MCL). There were 90 entries with a Federal or State MCL. In 54 of the 90 entries, the minimum value was listed in Columns P, Q or R indicating that the GW concentration limit calculated using Method A, Method B (noncancer) or Method B (Cancer) was more restrictive than the Federal or State MCL listed in Columns T and U. Some of the lower values from Method A, Method B (noncancer) or Method B (Cancer) were listed for contaminants that were included in the model. The native files for the next revision of the document have been revised to include MTCA Method B noncancer values in Table ES-1, Table 1-3, Table 5-1, Table 5-2, Table 8-3 and Table 8-4. The native files for the next revision of the PA have been revised to include MTCA Method A and Method B (noncancer) limits from the February 2021 update to the CLARC tables. The text has also been updated to include a comparison of the simulated results with the MTCA Method A and Method B (noncancer) limits.

Ecology Response 9/14/21: Disposition generally accepted with some exceptions. See subsequent comments for specific revisions needed for WAC 173-340 values.

HCRES11. P. ES-10, Table ES-1; Section 5.2, p 5-9 to 5-10, Tables 5-1 and 5-2. DD
USDOE divided this comment into 2 parts (a-b):

a. MTCA groundwater CULs (WAC 173-340-720) are missing in these tables (as implied by the MTCA groundwater pathway shown in Figures ES-5 and 3-1). Please include relevant MTCA groundwater ingestion CULs in these tables.

USDOE Disposition 7/9/21
Response: Accepted. See response to HCRES10. MTCA Method B noncancer values have been added to Tables ES-1, 5-1 and 5-2. The native files for the next revision of the document have been revised to include MTCA Method B noncancer values in Tables ES-1, 5-1 and 5-2 .

Ecology Response 8/30/21: Disposition accepted, pending revisions.

b. Re Table ES-1, the MCL for nitrite (as nitrite) is 3.3 mg/L (not 5 mg/L), and the groundwater concentration for F at the fence line for A Tank Farm (1.94E-1 mg/L) appears incorrect (given the much lower 100 m downgradient concentration and corresponding data in Table 5-1). Please revise. DD

USDOE Disposition 7/9/21
Response: Accepted. The value for F in Table ES-1 is incorrect. The value listed for F in Table ES-1 is inadvertently repeated using the value for nitrite. Tables 5-1 and 8-3 have the correct value from the model, 8.09E-04 mg/L. The MCL for nitrite is 3.3 mg/L, the

value listed in Table ES-1 (5 mg/L) is incorrect. The native files for the next revision of the document have already been updated with the indicated value corrections.

Ecology response 8/30/21: Disposition accepted, pending revisions.

HCRES12. P. ES-11 and ES-12, Tables ES-2 and ES-3, footnotes a & b; Section 8.1.1, p 8-4 to 8-5, Tables 8-1 and 8-2, footnote. DD

USDOE divided this comment into 3 parts (a-c):

a. In the absence of Cr+6 speciation, all of total Cr in groundwater should be assumed to be Cr^{+6} (as noted in footnote b).

USDOE Disposition 7/9/21
Response: RPP-ENV-58806 added Cr+3 and Cr+6 to analysis; the next revision of this document will do the same

Ecology Response 8/30/21: Disposition accepted, pending revision of RPP-ENV-62206, Rev 0

b. The inhalation RfC for Cr^{+6} mists/aerosols (IRIS, 8E-6 mg/m^3), as well as the IUR for Cr^{+6} (MTCA/CLARC and EPA/RSL tables, 8.4E-2 $[ug/m^3]^{-1}$) should be used to estimate respective noncancer HQ and cancer risk from inhalation (e.g., exposure to aerosol particles while showering).

USDOE Disposition 7/9/21
Response: A study by Finley et al (1996) determined that cancer risk from exposure during showering with Cr (VI) aerosols from tap water ranged from 9.0E-07 to 5.5E-06 from water containing 2 to 10 Cr(VI) mg/L. Average air-borne concentrations of Cr(VI) at breathing-zone height ranged from 0.087 µg/m3 to 0.324 µg/m3 which was measured over 24 hours of use. The air concentrations of 0.087 µg/m3 to 0.324 µg/m3 were directly correlated to water concentrations of 0.89 mg/L to 11.5 mg/L. This study concluded that exposure to indoor aerosols containing up to 10 mg/L is unlikely to create a health hazard. Finley et al (1996) also determined that ambient (outdoor) concentrations of Cr(VI) were about the same as those calculated from indoor shower aerosols (suggesting no difference between indoor and ambient air concentrations). Cr(VI) is evaluated as a COPC for the WMA A-AX Groundwater Impacts document, where Cr(VI) concentration at the A Farm fence line is 9 µg/L and is 2 µg/L at the AX Farm fence line. Cr(VI concentrations are less than WAC 173-340-720 groundwater cleanup level of 48 µg/L. Although there may be some potential for health hazards from exposure to Cr(VI) during showering at concentrations greater than 10 mg/L, this concentration is considerably greater than the levels identified for protection of human receptors and those modeled at the A and AX Farm fence lines.
We propose adding a section titled "Uncertainties Associated with Inhalation of Aersols Containing Hexavalent Chromium" containing the above text.
References:

ATSDR. 2012. Toxicological profile for chromium, U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, GA, accessed on 7/25/13 at http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=62&tid=17
Finley, BD, DG Dodge, SM Meyers, RO Richter, and DJ Paustenbach, 1996. Assessment of airborne hexavalent chromium in the home following use of contaminated tapwater, J. Expo. Anal. Environ. Epidemiol. Apr-Jun. 6(2): 229-24

Ecology response 8/30/21: Disposition accepted, pending revisions.

c. The oral RfD for Cr^{+6} (MTCA/CLARC and IRIS, 3E-3 mg/kg/d) and oral CSF for Cr^{+6} (EPA/RSL tables, NJDEP, and CalEPA, 0.5 $[mg/kg/d]^{-1}$) should be used to estimate respective noncancer HQ and cancer risk from groundwater ingestion. The oral CSF for Cr^{+6} is a valid EPA Tier 3 tox value (OSWER 9285.7-53 [see p 14-15 and p B-8 to B-12 at: https://semspub.epa.gov/work/HQ/163525.pdf]). Other web references for the oral CSF for Cr+6 include EPA/RSL tables (https://semspub.epa.gov/work/HQ/200043.pdf), CalEPA (https://oehha.ca.gov/chemicals/chromium-hexavalent), and NJDEP (https://oehha.ca.gov/media/downloads/water/comment/112509nj.pdf). The NJDEP study by Alan Stern (https://www.ncbi.nlm.nih.gov/pubmed/20843510) is based on an NTP (2008) chronic bioassay with rats and mice (https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr546.pdf). DD

USDOE Disposition 7/9/21
Response: No change. The toxicity values used for the hazardous substances evaluated in this analysis are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology Response 8/30/21: Disposition not accepted. For Cr+6, RPP-ENV-58813 conflicts with EPA guidance (OSWER 9285.7-53 [https://nepis.epa.gov/Exe/ZyPDF.cgi/91015CKS.PDF?Dockey=91015CKS.PDF] and OSWER 9285.7-86, [https://www.epa.gov/sites/default/files/2015-11/documents/tier3-toxicityvalue-whitepaper.pdf]). Together, these two OSWER guidance documents consider the oral CSF for Cr+6, as a valid EPA Tier 3 toxicity value, as described in the comment.

HCRES13. P. ES-13, Table ES-4; Section 3.1, p 3-3, Lines 1-10; Section 6.2.2, p 6-13, Table 6-3; Section 8.2, p 8-8, Table 8-5. DD

USDOE divided this comment into 2 parts (a & b):

a. Please define base case in Table ES-4 (via a footnote) as a scenario where safety functions behave as expected and anticipated retrieval and closure actions occur as planned.

USDOE Disposition 7/9/21

Response: Accepted. A foot note will be added to tables ES-4, 6-3 and 8-5 with the text "The Base Case is the scenario where safety functions behave as expected and anticipated retrieval and closure actions occur as planned.".

Ecology response 8/30/21: Disposition accepted, pending revisions.

b. Re INF1, INF2, and INF3 cases for AX tank farm in Table ES-4 (and Table 8-5), concentration and year data appear to be in error (are different than in Table 6-3 which appears more consistent with INF cases). DD

USDOE Disposition 7/9/21
Response: Accepted. The values in the table will be corrected.

Ecology response 8/30/21: Disposition accepted, pending revisions.

HCR1-1. Section 1.0, General. This document does not include a Preface that explains how it fits into the Appendix I Performance Assessment. A preface of this sort was included in the RCRA Closure Analysis of Waste Management Area C document (RPP-ENV-58806). Please add a Preface section to this document. BR

USDOE Disposition 7/9/21
Response: Accepted. The native files for the next revision of this document have been edited as suggested to include a preface indicating how the document, RPP-ENV-62206, fits into the requirements of the HFFACO Appendix I PA.

Ecology Response 9/14/21: Disposition accepted, pending revision.

HCR1-2. Section 1.0, p. 1-3, paragraph 3, lines 40-46: "In order to provide both DOE and Ecology information necessary to make a decision on the length of post-closure care time, this impacts analysis contains a long-term evaluation of contaminants remaining in the tanks and ancillary equipment because it may take hundreds to thousands of years for these contaminants to leach from the tank sources and travel through the vadose zone and unconfined aquifer to reach a potential receptor. Impacts from existing contamination in the soil within WMA A-AX will be evaluated in a future Analysis of Past Leaks and a future Risk Assessment for Soil (Figure 1-3)." Ecology disagrees with the submittal of multiple volumes of a PA and requests that USDOE submit a single PA for approval as a primary document so that all impacts can be evaluated. Ecology also understands this issue is being discussed in Holistic Negotiations and will accept text that reflects the resolution reached in that forum. TH

USDOE Disposition 7/9/21
Response: DOE intends to prepare a single document for the HFFACO Appendix I PA for WMA A-AX. The document will contain multiple volumes that segregate material addressed by different regulations. This approach should reduce some of the redundancy referred to in the comment. The scope of RPP-ENV-62206 is a post-closure fate and transport evaluation of dangerous chemicals in the waste residuals left in SSTs, ancillary equipment, and pipelines in WMA A-AX after the WMA is closed and

covered with an engineered surface barrier. The requested analysis for a cumulative evaluation of tank residuals, ancillary equipment residuals, pipeline residuals together with contamination in the vadose zone from past leaks is outside the scope of RPP-ENV-62206.
DOE will consider the development of a Synopsis document that provides a summary of the impacts of all the sources at WMA A-AX described in the different IPA volumes.

Ecology Response 7/26/21: Disposition accepted.

HCR1-3. Section 1.1, p. 1-7 and 1-8: "Closure decisions for dangerous / hazardous chemicals in the Hanford Site SST system soils will be made through the RCRA corrective action process. The RCRA corrective action component of the IPA will contain 1) a baseline risk assessment of the contaminated soil and vadose zone sediments and 2) an analysis of past leaks." All 4 "volumes" of the Appendix I PA are critical for the closure decision for the SST soils and ancillary equipment, including the DOE O 435.1 component of the PA. TH

USDOE Disposition 7/9/21
Response: DOE agrees that all four analyses are important to informing closure decisions. The risk assessment of the contaminated soil and vadose zone sediments and an analysis of past leaks which will address dangerous / hazardous chemicals will be prepared to support the RFI/CMS process for WMA A-AX. However, the DOE O 435.1 PA does not address dangerous / hazardous chemicals in the SSTs, ancillary equipment or pipelines.

Ecology Response 7/26/21: Disposition accepted.

HCR1-4. Section 1.1.1, p. 1-9, lines 5 through 22. The document states "While there is no guidance in WAC 173-303-610, WAC 173-303-640, or WAC 173-303-665(6) as to what a long-term impacts analysis should contain.." However, there is significant guidance regarding Ecology's expectations for environmental risk assessments for soil, water, air and ecological pathways in WAC 173-340 sections 700-760, which are referenced in WAC 173-303-646, corrective action (see sections -645(11) and -64620). There have been releases from these tank farms. Releases will require corrective action under WAC 173-303-646. Therefore, see WAC 173-340 sections 700-760 for guidance and regulations related to long-term risk analyses. BR

USDOE Disposition 7/9/21
Response: Partially Accept. This analysis only examines the potential impacts of residual waste in the tanks on groundwater under landfill closure conditions. Impacts from contaminated soil will be examined in an upcoming document. Ecological receptors will be examined in an upcoming baseline risk assessment. To address groundwater clean up levels, this analysis will use groundwater CULs from CLARC (Feb 2021 edition), which are based on equations and exposure assumptions presented in 2013 MTCA WAC 173-340-720, "Groundwater Cleanup Standards" and will be used to compare to the calculated groundwater concentrations.

Ecology Response 9/14/21: Disposition partially accepted. Ecology recognizes that this document covers only tank and ancillary equipment residuals. However, once the residual contaminants leave the tanks and ancillary equipment (in the future) they will migrate through vadose zone soils/sediments to groundwater. This comment was pointing to regulations (with guidance) that apply once the residuals leave the tanks and ancillary equipment.

HCR1-5. Section 1.1.1, p. 1-9, Second Paragraph, lines 24-26: "WAC 173-303-665(2)(b) does not apply to tank systems, but because WMA A-AX does not have a liner and/or leachate collection system, it is being brought forward to assist in determining what information/data Ecology might need to support closure decisions." It is inaccurate to state that WAC 173-303-665(2)(b) does not apply to tank systems. It is more accurate to state that WAC 173-303-665 does not include clear requirements for tank systems closing as a landfill. TH

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been edited to clarify that WAC 173-303-665 does not include clear requirements for tank systems closing as a landfill.

Ecology Response 7/26/21: Disposition accepted.

HCR1-6(1). Section 1.2, p. 1-16, lines 21 -36. The text states "Past leak events are not addressed in this analysis. However, these events will be addressed in a risk assessment for soil and an analysis of past leaks (Figure 1-3), which will both support the WMA A-AX RFI/CMS." Ecology expects all source terms, including past releases, to be included in the WMA A-AX Appendix I PA, to be consistent with Section 2.5 of Appendix I of the Hanford Tri-Party Agreement. This section states "As each WMA proceeds toward closure, its respective PA will be updated to address all pertinent new results and findings – and will, as a minimum, incorporate the following results as they become available: actual volumes of tank waste residuals left after retrieval, results of leak investigations, new geologic and ancillary equipment waste characterization information, and the results of new barrier and tank residual stabilization and fill performance studies and tests." BR

USDOE Disposition 7/9/21

Response: DOE intends to prepare a single document for the HFFACO Appendix I PA for WMAA-AX. The document will contain multiple volumes that segregate material addressed by different regulations. This approach should reduce some of the redundancy referred to in the comment. The scope of RPP-ENV-62206 is a post-closure fate and transport evaluation of dangerous chemicals in the waste residuals left in SSTs, ancillary equipment, and pipelines in WMA A-AX after the WMA is closed and covered with an engineered surface barrier. The requested analysis for a cumulative evaluation of tank residuals, ancillary equipment residuals, pipeline residuals together with contamination in the vadose zone from past leaks is outside the scope of RPP-ENV-62206.

DOE will consider the development of a Synopsis document that provides a summary of the impacts of all the sources at WMA A-AX described in the different IPA volumes.

Ecology Response 9/14/21: Disposition partially accepted. The single document approach is what Ecology has requested. We will need to see the single document to fully accept.

HCR1-6(2). Section 1.2, p. 1-17, lines 2-5, and footnote 9: “Together with WMA A-AX, these DST farms form the “A Complex” of tank farms which, given their proximity, are expected to be closed with a common surface barrier or a set of essentially continuous surface barriers” The footnote states that interim barrier may be used for individual tank farms. Please include the statement that a surface barrier is required, and must meet or exceed the performance of a RCRA Subtitle C barrier at the time of closure. TH

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been edited to clarify that a surface barrier with performance equal to or better than a RCRA Subtitle C barrier is required. The following text will be added to the discussion: "These surface barriers are required and will meet or exceed the performance of a RCRA Subtitle C barrier at the time of closure."

Ecology Response 7/26/21: Disposition accepted.

HCR1-7. Section 1.3.2, p. 1-18, lines 36-38: “Since the closure cover is not expected to be built for 30 years, the final cover design will occur in the future and calculations can be used to inform the final design requirements.” Please reference applicable TPA milestone series requiring 90% cover design and applicable schedule dates, or reference the WMA A-AX Tier 2 closure plan which will include the compliance schedule for placement of the final barrier. TH

USDOE Disposition 7/9/21

Response: Not accepted. The TPA does not have milestones for completing the final barrier designed over WMA A-AX. Milestone M-045-92 addresses interim barriers in other WMAs, but is not applicable to the discussion in this part of the document.

Ecology Response 9/27/21: The response provided by USDOE does not address the comment. USDOE has proposed and evaluated a barrier in this document. USDOE should include an explanation of the barrier placement as part of this evaluation (both interim and final barriers). USDOE does have a milestone for submitting a closure plan (M-045-103) and that submittal will be part of the SST System Permit for closure. As such, the Tier 2 Closure Plan must meet the requirements for closure and in this case a compliance schedule for closure. The Ecology comment identifies a deficiency, with a proposed solution. Acceptance of our comment is not a consideration, a proposed resolution is necessary.

HCR1-8. Section 1.3.3 and Section 1.6.1, p. 1-20 and p. 1-40, Table 1-1 and Table 1-4, Exposure point. The exposure point given here is assumed to be 100 m downgradient at the point of highest exposure. Ecology uses exposure points that correspond to points of compliance in our regulations: see WAC 173-340-720(6)(b) “The standard point of compliance shall be established

throughout the site from the uppermost level of the saturated zone extending vertically to the lowest most depth which could potentially be affected by the site." Also see WAC 173-303-645(6)(a) "The point of compliance is a vertical surface located at the hydraulically down-gradient limit of the waste management area that extends down to the uppermost aquifer underlying the regulated units." Since this document is intended to address Dangerous Waste/RCRA requirements, risk calculations are expected to address the state's points of compliance, in addition to or rather than the assumed exposure point for DOE O 435.1. BR

USDOE Disposition 7/9/21

Response: Accepted. RPP-ENV-62206 performs calculations at points of calculation aligned with the WMA fence line and at a location in the groundwater 100-m from the WMA fence line. The reported results for the fence line point of calculation are meant to provide information that would be consistent with the point of compliance in WAC 173-303- 645(6)(a) (the hydraulically down- gradient limit of the waste management area). The native files for the next revision of this document have been edited to include this discussion in Table 1-1.

Ecology Response 9/14/21: Disposition accepted, pending revision.

HCR1-9. Section 1.6.1, p. 1-39, Table 1-3. BR, DD

USDOE had divided this comment into 4 parts (a-d):

a. The state follows WAC 173-303 standards, which are not limited to MCLs for groundwater. See the requirements in WAC 173-303-64620(4).

USDOE Disposition 7/9/21

*Response: Accepted. The native files for the next revision of this document have been edited to include tabulation and comparison to MTCA Method A and Method B (noncancer) limits reported in the February 2021 update to CLARC, which was downloaded from https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contaminationclean-up-tools/CLARC/Data-tables on May 3, 2021. However, the analysis has not been updated to include a comparison to surface water cleanup standards per WAC 173-340-730 (see response to **HCRES7**).*

Ecology response 8/30/21: Disposition not accepted. See Ecology response to HCRES7 and HCRES8.

b. There have been releases from this tank farm so corrective action will be required and would be required if the tanks release in the future.

USDOE Disposition 7/9/21

Response: The scope of this comment is the not the subject of this document. This document focuses on the human and environmental impacts for waste residuals left in tanks and ancillary equipment. This scope is briefly described in the Preface on p. 1-1 and p. 1-4

Ecology response 8/30/21: Disposition not accepted. Before USDOE fragmented this comment, the first part read, "The state follows WAC 173-303 standards, which are not limited to MCLs for groundwater. See the requirements in WAC 173-303-64620(4). There have been releases from this tank farm so corrective action will be required and would be required if the tanks release in the future." Therefore, the statement simply refers to corrective action, consistent with the regulatory citation (WAC 173-303-64620(4)). Also, the scope of this document does include modeling future releases from the tanks and ancillary equipment and contaminant migration through vadose zone soil/sediments to groundwater. Please revise the disposition.

c. Also, there are many more constituents given in the BBI database and all need to be considered in this report, until data from the tanks (and vadose zone) are available.

USDOE Disposition 7/9/21

Response: Partially accepted. The preliminary PA and RCRA Impacts Analysis include multiple COPCs, but not all COPCs included in the BBI. As indicated on RPP-RNV-62206 Page 4-28 a screening analysis for modeling impacts to groundwater was used to limit the list of simulated COPCs. The low net infiltration rate anticipated in the post-closure time period coupled with the thick vadose zone lead to vadose zone transport times that are on the order of thousands of years. A screening analysis performed for the WMA C PA concluded that under post-closure conditions, COPCs with a K_d greater than 1.5 ml/g for the Hanford formation sand units (H1 and H2) would not reach the groundwater for tens of thousands of years . The preliminary WMA A-AX PA results for uranium corroborate that this is also the case for conditions at WMA A-AX; uranium has a K_d equal to 0.6 ml/g in the model and is just beginning to breakthrough to the groundwater at the end of the 10,000 year simulation. Therefore, it is not necessary to simulate all species, but COPCs identified in the DQO for tank closure activities (RPP-23403) should be addressed. The next revision of this document will update the discussion of COPC screening as it applies to COPCs in the DQO for tank closure activities (RPP-23403).

Part of the COPC screening update may also be augmented with a discussion of how COPCs with residual waste concentrations lower than method detection limits are screened and how COPCs with the same K_ds can be simulated using surrogates. For instance, every non-sorbing COPC will travel from the source to the groundwater at the same rate. Unless the COPC is constrained by solubility at the source, simulating a single surrogate can be used to represent the entire group of COPCs that travel at the same rate. The simulated groundwater concentrations for each COPC could be scaled from the initial inventory of the surrogate and the initial inventory of the COPC. The updated discussion will provide an equation for how groundwater concentrations for different inventories can be scaled from surrogates to obtain the groundwater concentrations for the COPC.

Ecology response 8/30/21: Disposition partially accepted, pending revisions.

d. Furthermore, we emphasize that the EPA tap water scenario given in Figure 3-1, Section 3.2.3, Section 4.2.5, Section 8.1.1, and throughout the document is an additional line of evidence to Ecology, but it alone does not meet the requirements in WAC 173-303 for closure. We will use WAC 173-340 scenarios and associated calculations during the closure process for making decisions in accordance with our regulations. Specific values from Ecology's regulations, for the constituents in Table 1-3, are:

Chemical	WAC 173-340-720 Eqn 720-1, 720-2 (μg/L)	WAC 173-340-730 Section (3) (μg/L)	MCL (μg/L) (lowest of state and federal)	90th percentile background (DOE/RL-96-61) when limiting (μg/L)
Al	1.6E04	None	None	Below -720 value
Cr (VI)[a]	4.8E01	1E01	1E02 total Cr	Below -730 value
F	9.6E02	None	4E03	1.05E03
Fe	1.1E04	1E03	None	Below -730 value
Hg	None	1.2E-02	2E00	Below -730 value
Mn	7.5E02	5E01	None	Below -730 value
Ni	3.2E02	136	1E02	Below MCL
Nitrate-N	2.6E04	1E04	1E04	Below -730 value
Nitrite-N	1.6E03	None	1E03	Below -730 value
Pb	1.5E01	2.1E00	1.5E01	Below -730 value
Sr	9.6E03	None	None	Below -720 value
Utotal	3.2E00	None	3E01	9.85E00

[a] Cr^{+6} (4.8E1 μg/L) with oral RfD=3E-3 mg/kg/d; 0.2 μg/L with NJDEP/CalEPA oral CSF=0.5 $[mg/kg/d]^{-1}$)

BR, DD

USDOE Disposition 7/9/21

Response: Partially Accepted. This analysis examines the potential impacts of residual waste in the tanks on groundwater. Impacts from contaminated soil will be examined in a separate report required by the TPA Appendix I process. To address CULs for groundwater, this analysis will use CULs from CLARC (Feb 2021 edition) to compare to the calculated groundwater concentrations (these CULs match those in the table provided in the comment). Text will be added in this section stating that groundwater CULs from CLARC will be used for comparison to predicted groundwater concentrations.

Ecology response 8/30/21: Disposition partially accepted. In addition to groundwater CULs, note that MTCA surface water CULs (listed in the comment table [WAC 173-340-730]) should also be compared against modeled surface water concentrations.

HCR2-1. Section 2.1.1.2.2, p. 2-8, lines 42-44: “This evaluation addresses releases from residual waste left in the SSTs, pipelines, and ancillary equipment; therefore, evaluation of these UPRs is outside the scope of the current impacts analysis and will be addressed through the RCRA Corrective Action process.” Are the UPRs planned for inclusion in the RFI/CMS? If so, please state that here, and clarify that the PA will be updated after that analysis is completed. TH

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been updated to replace the text starting on line 43 ("…evaluation of these UPRs is outside the scope of the current impacts analysis and will be addressed through the RCRA Corrective Action process.") with: "...as identified in Section 1, the impacts from the UPRs are not considered under the scope of this impacts analysis; but rather, will be addressed through the RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) process. The Appendix I PA will be updated upon completion of the RFI/CMS."

Ecology Response 7/26/21: Disposition accepted.

HCR2-2. Section 2.1.5.4.3, p. 2-81 – 2-97 Groundwater near A-AX has a number of contaminants over levels of concern for groundwater and/or surface water in the past 10 years:

Well	Nonradiological Contaminants	GW limit exceeded	SW limit exceeded	Years
299-E25-2	Arsenic	Method B	Various	2008, 2018
	Dibenz[a,h]anthracene	Method B	Various	2016
	Heptachlorodibenzofuran		Various	2016
	Hexachlorobenzo-p-dioxin	Method B	Various	2016, 2017, 2019
	Ideno(1,2,3-cd)pyrene	Method B	Various	2016
	Nitrate-N	Method B, MCL		2012-present
	Pentachlorodibenzofurans		Various	2016
	Pentachlorodibenzo-p-dioxin	Method B	Various	2016
	Selenium		Aquatic	2019
	Tetrachlorodibenzofurans		Various	2016
	Tetrachlorodibenzo-p-dioxins	Method B	Various	2016, 2017, 2019
299-E25-40	Arsenic	Method B, MCL	Various	2013 – 2018
	Chromium	MCL		2017

Well	Nonradiological Contaminants	GW limit exceeded	SW limit exceeded	Years
	Cyanide	Method B		2019
	Hexachlorobenzo-p-dioxin		Various	2016 – 2019
	Nitrate-N	Method B, MCL		2011 – 2019
	Pentachlorodibenzo-p-dioxin		Various	2016
	Tetrachlorodibenzofurans		Various	2019
299-E25-41	Arsenic	Method B	Various	1990s – 2019
	Heptachlorodibenzofuran		Various	2016
	Hexachlorobenzo-p-dioxin		Various	2016
	Methylene chloride	MCL		2016
	Nitrate-N	Method B, MCL		2006 – 2019
	Pentachlorodibenzo-p-dioxin		Various	2016
	Tetrachlorodibenzo-p-dioxins		Various	2016
299-E25-93	Arsenic	Method B	Various	2013 – 2019
	Hexachlorobenzo-p-dioxin		Various	2016, 2019
	Nitrate-N	Method B, MCL		2003 – 2019
	Pentachlorodibenzo-p-dioxin		Various	2019
	Tetrachlorodibenzofurans		Various	2016, 2019
	Tetrachlorodibenzo-p-dioxins		Various	2019
299-E25-94	Aroclor-1260	Method B		2019
	Arsenic	Method B	Various	2013, 2018
	Cyanide	Method B		2018, 2019
	Heptachlorodibenzofuran		Various	2016, 2018
	Hexachlorobenzo-p-dioxin		Various	2016, 2017
	Iron		Aquatic CWA 304 fresh water	2014
	Nitrate-N	Method B, MCL		2004 – 2019
	Pentachlorodibenzofurans		Various	2016

Well	Nonradiological Contaminants	GW limit exceeded	SW limit exceeded	Years
	Pentachlorodibenzo-p-dioxin Selenium Tetrachlorodibenzofurans Tetrachlorodibenzo-p-dioxins	Method B	Various Aquatic WAC 173-201A Various Various	2019 2016, 2017 2016 2016, 2017

Many of these contaminants are not considered in the BBI dataset, and inventory values are not available. However, as retrieval data are obtained, it will be necessary to look at all of the contaminants and determine if WMA A-AX releases have contributed to the contamination in nearby groundwater. [Note: Details about the assumptions and exact dates can be provided]. BR

USDOE Disposition 7/9/21

Response: Not accepted for this document. There is no action that DOE can take in RPP-ENV-62206 that can address this comment. RPP-ENV-62206 is a post-closure analysis of tank and ancillary equipment residuals under landfill closure conditions. Evaluating past releases from WMA A-AX is outside the scope of RPP-ENV-62206.

Ecology Response 9/15/21: Disposition not accepted. Ecology will be looking for data associated with these contaminants in samples from retrieved tanks. Ecology assumes that these contaminants will be evaluated in residual samples when the tanks are retrieved. WMA A-AX tanks may be a continuing source of the contaminants that are currently in groundwater. Therefore, these contaminants may be found in tank residuals when they are sampled before closure. Some of these, if present in tank residuals, may noticeably change the current risk predictions. Currently, there is significant uncertainty in the risk results, since they are based on just BBI information.

HCR2-3. Section 2.1.8 (or elsewhere in Section 2.0). The 200-E-286-Ditch should be discussed along with its association with well corrosion. At least three wells were lost at WMA A-AX due to well corrosion. At the three corroded and decommissioned wells, the corrosion occurred above the water table at (or slightly above) a fine-grained geologic unit (the Cold Creek silt-dominated unit [CCUz]). This unit creates perching conditions for groundwater (percolating downward between the surface and the water table) and greatly increases lateral spreading. The most likely source of the corrosion is chloride-bearing effluent from the 200 East Area powerhouse (284-E Powerhouse) that was discharged to an unlined ditch (200-E-286 Ditch) that traversed the southwest end of what later became the 241-A Tank Farm (Figure 1-2). This ditch was active from 1946 to 1953. The CCUz fine-grained unit and the increased amount of lateral spreading of the chloride-bearing waste water are the subject of the next three comments. JWL

USDOE Disposition 7/9/21

Response: RPP-ENV-62206 is a post-closure analysis of tank and ancillary equipment residuals under landfill closure conditions. The simulations include the CCUz as detailed in RPP-RPT-60171 Table 3-1. In the geoframework model described by RPP-RPT-60171, the CCUz in the vicinity has a maximum observed thickness in a borehole that is 4.57 m, but the average CCUz thickness in the boreholes used to develop the geoframework model is 1.7 m. This CCUz layer is included in the fate and transport model and if modeling suggested lateral spreading would occur because of this unit under the closed conditions, it would be reflected in the simulation results.
As a post-closure analysis, the simulations assume an engineered barrier that lasts up to 500 years will be placed over the residual waste. Flow in the vadose zone underneath a barrier is significantly different than flow through the vadose zone with anthropogenic recharge from discharges to unlined ditches as discussed in the comment. Lateral spreading beneath a closed WMA should not be expected to be the same as lateral spreading that might result from high volume discharges being impeded by a silt layer.

Ecology Response 9/13/21: Disposition accepted.

HCR3-1. Section 3.2, p. 3-11, 3rd paragraph, and p. 3-12 second paragraph. – Use of the "Ecology Advocacy Model" and fine-grained model of WMA C to evaluate transport of contaminants to the water table at WMA C may not be appropriate for a similar evaluation at WMA A-AX. The CCUz silt unit at WMA A-AX is not present at WMA C. The two sites are not comparable in terms of heterogeneity. The CCUz at WMA A-AX is up to 35-ft thick over the waste management area. There is nothing comparable at WMA C and potential for lateral spreading of contaminants in the vadose zone. JWL

USDOE Disposition 7/9/21
Response: RPP-ENV-62206 is a post-closure analysis of tank and ancillary equipment residuals under landfill closure conditions. The simulations include the CCUz as detailed in RPP-RPT-60171 Table 3-1. In the geoframework model described by RPP-RPT-60171, the CCUz in the vicinity has a maximum observed thickness in a borehole that is 4.57 m, but the average CCUz thickness in the boreholes used to develop the geoframework model is 1.7 m. This CCUz layer is included in the fate and transport model and if modeling suggested lateral spreading would occur because of this unit under the closed conditions, it would be reflected in the simulation results.
As a post-closure analysis, the simulations assume an engineered barrier that lasts up to 500 years will be placed over the residual waste. Flow in the vadose zone underneath a barrier is significantly different than flow through the vadose zone with anthropogenic recharge from discharges to unlined ditches as discussed in the comment. Lateral spreading beneath a closed WMA should not be expected to be the same as lateral spreading that might resultfrom high volume discharges being impeded by a silt layer.
Please also see the response for Ecology comment # HCR4-1 for a discussion regarding vadose zone heterogeneity.

Ecology Response 9/13/21: Disposition accepted.

HCR3-2. Section 3.2.2.1.2, p. 3-37 – 3-41, and throughout the document. Recharge assumptions. BR

- The text on lines 12 – 14 of p. 3-38 refer to the water balance equation on line 7 of p. 3-38, and state "By directly measuring or estimating the parameters on the right hand side under controlled conditions, the recharge can be calculated." Please state which parameters are measured, and which are estimated. Please provide any equations used to estimate the estimated parameters.

USDOE Disposition 7/9/21

Response: The equation on page 3-38 represents the water balance in which recharge is the residual from the terms on the right-hand side of the equation. That the recharge can be calculated from the parameters on the right hand side is a simple statement of the mathematics. The use of any specific equations or measurement techniques to provide estimates of the parameters on the right-hand side of the equation is not implied.

Ecology response 9/14/21: Disposition not accepted. Please state which parameters are measured, and which are estimated. Please provide any equations used to estimate the estimated parameters.

- RPP-RPT-60885, Appendix A gives the following assumption: Section A.1.3 states "The design life of the cover is 500 years in the nominal case, following which the infiltration through the cover returns to the site-wide average infiltration rate for undisturbed soil." This assumption cannot be ensured. Lack of human disturbance for 500 years can never be guaranteed.

Response: DOE/RL-93-33 indicates that 500 years is the design life criterion for the modified RCRA C barrier design. The assumption of 500 years is consistent with the NRC's Performance Assessment Working Group recommendation that assuming engineered barriers become physically degraded after 500 years following site closure limits unnecessary speculation as to their performance (NUREG-1573). Credit for structural stability and chemical buffering effects may be taken for even longer periods of time, with sufficient justification. PNNL-16688 reasserts the conclusions presented in PNNL-14744, that the performance of the surface barrier should not diminish after its design life. Processes likely to affect performance, such as bioturbation and wind and water erosion do not appear to be consequential enough to be detrimental to performance as demonstrated using sensitivity cases that evaluate different barrier performance evolutions. INF2 is expected to be bounding of a case that has significantly wetter futures and poorer surface cover performance, but not wetter climates with no surface cover. In this scenario, groundwater concentrations at the point of calculation still met MTCA standards.

Ecology response 9/14/21: This bullet made reference to human disturbance. Though human disturbance can also damage grout within the tank, we may use INF2 to represent the impacts of human disturbance on the surface.

- Another assumption is given in Section 4.2.2.2: "The transition period from the young revegetated shrub steppe to the mature shrub steppe community is assumed to require 30 years, which is the assumption included in PNNL-14702." Wildfire alters vegetation succession, and therefore infiltration rates. For example, the Hanford site had 302 wildfires in the years 1990-2010 (USDOE, 2011)). Lesica, et al. (2007, Recovery of big sagebrush following fire in Southwest Montana, Rangeland Ecol. Manage. 60:261-269) found that Wyoming big sagebrush had only 2% recovery in 23 years after fires on plot studies in southwest Montana, and modeling suggested that full recovery for Wyoming big sagebrush after fires would be greater than 30 years "and probably much more." Wyoming big sagebrush is the major subspecies of big sagebrush at Hanford (PNNL-13688). Invasive species (e.g., cheatgrass, a common invasive species after fire, which results in a higher recharge rates at least 5 times greater than that of native shrub-steppe (Gee, GW, MJ Fayer, ML Rockhold, and MD Campbell. 1992. Variations in recharge at the Hanford Site, Northwest Science, 66(4):237-249). It has been found that shrub steppe vegetation does not easily re-establish after cheatgrass invasion (Norton, JB, TA Monaco, JM Norton, DA Johnson, TA Jones. 2004. Soil morphology and organic matter dynamics under cheatgrass and sagebrush-steppe plant communities. J. of Arid Environments 57:445-466).

Response: Data collected at Hanford and other arid regions indicate that 30 years is ample time to reestablish a mature shrub-steppe community, and achieve the associated reduction in recharge rate. Revegetation follows the strategy and approach documented in Revision 2 of DOE/RL-2011-116, Hanford Site Revegetation Manual, which identifies Big sagebrush, Artemisia tridentate, as the revegetation shrub. The manual provides clear and consistent direction regarding revegetation, restoration, and stabilization actions to meet and support DOE long-term stewardship goals, and ensure that revegetation actions are appropriate and achieve environmental compliance. Big sagebrush grows rapidly and seedling survival is high for seed collections planted in a habitat similar to that of the parent population (FEIS database http://www.fs.fed.us/database/feis/plants/shrub/arttrit/all.html). While Lesica, et al. (2007) indicates that the recovery of Wyoming sagebrush may be much longer than 30 years, the recovery of basin (ssp. tridentata) is shorter than the 32 years indicated for big mountain sagebrush (ssp. vasseyana [Rydb.] Beetle). Furthermore, there we will elements in the engineered surface barrier (i.e., storage capacity of the silt loam, the capillary breaks, and biointrusion barriers) that are expected to dampen both the short-term and long-term effects of changing surface conditions regardless of whether the native ecology or an invasive species dominates the landscape. Sensitivity cases have evaluated the consequences that are worse than would be assumed under cheatgrass domination. INF2 is expected to be bounding of a case that has significantly wetter futures and poorer surface cover performance, but not wetter climates with no surface cover. In this scenario, groundwater concentrations at the point of calculation still met MTCA standards.

Furthermore, "Central Plateau Inner Area Cleanup Principles and Parameters" (DOE/RL-2019-46), which is signed by both the U.S. Environmental Protection Agency and the Washington State Department of Ecology, includes methods and approaches for waste sites located within and underneath SST WMAs. The method for evaluating groundwater protection specifically includes a evapotranspiration barrier scenario that specifies an effective infiltration rate of 0.5 mm/yr after the barrier is installed and 4 mm/yr (referred to as the natural land cover rate) after the 500 year design life. Modeling in RPP-ENV-62206 is consistent with this scenario.

Ecology response 9/14/21*:* Disposition not accepted. Wyoming big sagebrush is a subspecies of big sagebrush. There are five subspecies of big sagebrush:

(1) A. tridentata subsp. tridentata, basin big sagebrush
(2) A. tridentata subsp. spiciformis (Osterhout) Kartesz & Gandhi, snowfield big sagebrush
(3) A. tridentata subsp. vaseyana (Rydb.) Beetle , mountain big sagebrush
(4) A. tridentata subsp. wyomingensis Beetle & Young ,Wyoming big sagebrush
(5) A. tridentata subsp. xericensis Winward ex Rosentreter & R. Kelsey, xeric big sagebrush

https://www.fs.fed.us/database/feis/plants/shrub/arttrit/all.html

Revision 2 of DOE/RL-2011-116, Hanford Site Revegetation Manual, does not specify the subspecies of big sagebrush to be planted at Hanford. However, Wyoming big sagebrush is the dominant big sagebrush subspecies at Hanford (PNNL-13688, Vascular Plants of the Hanford Site, p. 3.9). Basin big sagebrush is present near the Yakima River delta. Since basin big sagebrush and mountain big sagebrush are not the dominant types at Hanford, they may not be successful for revegetating the tank farms. Several references, (ex. Lesica, P, SV Cooper, G Kudray. 2007. Recovery of big sagebrush following fire in Southwest Montana, Rangeland Ecol. Manage. 60:261-269; Norton, JB, TA Monaco, JM Norton, DA Johnson, TA Jones. 2004. Soil morphology and organic matter dynamics under cheatgrass and sagebrush-steppe plant communities. J. of Arid Environments 57:445-466; Pyke, DA, JC Chambers, JL Beck, ML Brooks, BA Mealor. 2016. Land uses, fire and invasion: exotic annual Bromus and human dimensions. In: Germino, MJ, JC Chambers, CS Brown (Eds.) Exotic brome-grasses in arid and semiarid ecosystems of the Western US: causes, consequences and management implications. Springer, New York, NY, USA, pp. 307-338) indicate that big sagebrush (especially Wyoming big sagebrush) does not recover in 30 years in environments where invasive cheat grass becomes dominant after fires.

- The following assumptions from Section A.1.3 "Impacts resulting from plausible climate change that may occur during the evaluation period do not adversely impact the performance of the surface or vadose zone as a barrier." And "Net infiltration through the thick, heterogeneous vadose zone in the 200 Areas dampens the effect of discrete events, and therefore episodic precipitation events can be replaced by an average annual recharge rate." are questionable. [Section A.2.2 has a related assumption, that there will not be significant climate change based on estimates of past climates in the area]. Climate change could result in extreme summer droughts that destroy the vegetation and/or lead to increasing fire frequency which would favor invasives like cheatgrass rather than deeply-rooted shrubs. This would potentially result in decreased

water removal during dry seasons, and would not prevent winter precipitation from going below the root zone. Climate change may result in dune migration through the tank farm, changing the water use efficiency of the vegetation due to burial. Climate change could result in greater winter precipitation, reduced evapotranspiration as a result of more effective precipitation and deeper percolation from events, which would result in overall higher annual recharge amounts.

Response: In arid and semiarid regions with a thick vadose zone, the vadose zone acts essentially as a buffer or signal dampener between climate or weather changes at the surface and recharge entering the groundwater. The lag time between deep drainage, the flux of water leaving the evapotranspiration zone, and groundwater recharge can be hundreds to thousands of years (PNNL-16688, 2007). Arid and semiarid environments exert a strong selective pressure on plants to maximize soil water extraction, and access to scarce soil water dictates the activities and interactions among the plants (Seyfried, M. S., S. Schwinning, M. A. Walvoord, W. T. Pockman, B. D. Newman, R. B. Jackson, and F. M. Phillips, 2005, "Ecohydrological Control of Deep Drainage in Arid and Semiarid Regions," Ecology, 86(2), pp. 277–287). If climate change results in distinct changes in the future precipitation and/or temperature characteristics of the Hanford Site, then commensurate changes in the ecology would be expected to accompany the climate change.

"Central Plateau Inner Area Cleanup Principles and Parameters" (DOE/RL-2019-46), includes methods and approaches for waste sites located within and underneath SST WMAs. The method for evaluating groundwater protection specifically includes a evapotranspiration barrier scenario that specifies an effective infiltration rate of 0.5 mm/yr after the barrier is installed and 4 mm/yr (referred to as the natural land cover rate) after the 500 year design life. Modeling in RPP-ENV-62206 is consistent with this scenario. The post-design net infiltration estimate of 3.5 mm/yr is about double the rate estimated in PNNL-16688 for Rupert sand (1.7 mm/yr) in order to address uncertainty in future conditions. Greater recharge rates up to 5 mm/yr were included in the uncertainty analysis for the PA and the late recharge rate has some influence on the uncertainty in the dose result.

In addition, sensitivity cases have evaluated the consequences that are both better than and considerably worse than the prescribe evolution of net infiltration rates assumed in the base case. INF2 is expected to be bounding of a case that has significantly wetter futures and poorer surface cover performance, but not wetter climates with no surface cover. In this scenario, groundwater concentrations at the point of calculation still met MTCA standards.

Ecology response 9/14/21: Disposition not accepted. This portion of the comment indicates that total annual recharge is the parameter of concern in the case of climate change, due in part to a possible decrease in evapotranspiration at the surface. The thickness of the vadose zone is not a factor in this case. Notice that INF2 (Figure 6-3) is bounding in the first 1000 y, but not at later times. Please show (on Figure 6-3) a comparison between the requested sensitivity case and the cases that DOE considers to be a bounding. We request a case with 100 mm/y recharge until 2050, 0.5 mm/y for 100 y after barrier placement, and 22 mm/y thereafter to represent a surface that has been burned and occupied by invasives such as cheatgrass (PNNL-14702, Rev.1, Table 4.15).

- Another assumption, from Section A.2.1 is "It is assumed that the natural shrub-steppe ecology established prior to site operations is re-established in the footprint of the WMA (i.e., the top of the surface barrier) and surrounding area during the post-closure period. Justification: Once operational activities on the site cease, ecological forces will reestablish a native vegetation that has adapted to the regional climate. Unfortunately, invasives, such as cheatgrass, are well adapted to the regional climate and are strongly competitive with the natural shrub-steppe ecology.
  Due to the above concerns, Ecology requests a sensitivity evaluation with 100 mm/y recharge until 2050, 0.5 mm/y for 100 y after barrier placement, and 22 mm/y thereafter to represent a surface that has been burned and occupied by invasives such as cheatgrass (PNNL-14702, Rev.1, Table 4.15). The long-term value of 22 mm/y would be roughly half of the WAC 173-340-747(5)(f)(ii)(A) default value for eastern Washington: 25% of annual precipitation (25% of 173 mm/y is approximately 43 mm/y). Please provide this sensitivity analysis in Section 8.2, and ultimately in the Past Leaks portion of the WMA A-AX IPA. While it might be reasoned that the sensitivity case with an unvegetated gravel surface is more extreme than this, the cheatgrass case should be given more weight with the current closure assumptions, unless a decision is made to leave the tank farm surface unvegetated with gravel. BR

Response: It is reasoned that the sensitivity case with an unvegetated gravel surface is more extreme than this and bounds the results of the requested analysis. INF2 is expected to be bounding of a case that has significantly wetter futures and poorer surface cover performance, but not wetter climates with no surface cover. In this scenario, groundwater concentrations at the point of calculation still met MTCA standards. Since DOE does not "weight" different scenarios when they all meet the performance requirements, evaluating conditions that are less bounding than a bounding case that meets all necessary performance requirements is generally not performed. Performing this case will be considered for a future revision of this document and a similar scenario will be considered for the past leaks analysis.

Ecology response 9/14/21*:* The overall comment disposition is not accepted for reasons stated above. Please show a comparison between the requested sensitivity case and the case that DOE considers to be a bounding case.

HCR3-3. Section 3.2.2.1.6, p. 3-44: Summary of Assumptions for Groundwater Pathway as outlined in the following bullet items are not always true and needs further discussions clarifications with examples and references**.** DG

- "The inclusion of moisture-dependent anisotropy functions allows the homogeneous HSUs to adequately approximate the effects of heterogeneity". *Please note that both Ecology and USDOE used alternative conceptual model to address multiple aspects in the C-Tank Farm PA*

USDOE Disposition 7/9/21

Response: See response to HCR4-1 on DOE's position regarding subsurface heterogeneity and the application of the equivalent homogeneous media.

The results produced in previous cross-sectional modeling evaluations done for Ecology that compared the Equivalent Homogeneous Media approach with other ACMs with heterogeneity was generally consistent with results produced in the other two referenced studies done at WMA C. The other studies were based on examining the effect of other alternative conceptual models of subsurface heterogeneities of both past leaks and tank residuals using more detailed three-dimensional modeling.
In the work done with Ecology and in the other studies at WMA C, the EHM representation of the vadose zone which included the moisture-dependent anisotropy functionality generally produced the least amount of plume spreading and a more pessimistic and higher peak mass flux at the water table when compared to all other analyses incorporating additional alternative interpretation of heterogeneity. Thus, from an overall facility impact perspective, the EHM approach with the implemented moisture-dependent anisotropy functionality has been shown to provide a reasonable approach for assessment of downgradient groundwater impacts from both past leak s and residual wastes left in a landfill-closed WMA A-AX.
As mentioned in the previous response, it is DOE's position that the detailed analyses of the effects of the EHM approach cited here with other ACMs that explicitly represent subsurface heterogeneity performed at WMA C is very applicable to conditions at WMA A-AX and that a detailed reanalysis of the effects of these types of heterogeneities in the vadose zone for hydrogeologic conditions at WMA A-AX is not warranted at this time and would serve only to confirm the general results of the modeling studies that were produced at WMA C.

Ecology response 9/23/21: The overall comment disposition is not accepted at this time. Ecology requests a meeting to discuss these issues.

- "The hydrostratigraphy of the vadose zone is adequately represented by the delineation of equivalent homogeneous units for evaluating bulk (or mean) flow and contaminant transport". *It is not clear from the field data (e.g. heterogeneity and moisture profile, etc.) that one can conclude the above statement without more analysis.*

Response: See response to HCR4-1 on DOE's position regarding subsurface heterogeneity and the application of the equivalent homogeneous media.

- "Vadose zone hydraulic property values up scaled from small- and micro-scale (sample) measurements apply to the field scale for the equivalent homogeneous units". *Detail sensitivity analysis with multiple realizations approach should be evaluated before moving forward with this single concept.*

Response: See response to HCR4-1 on DOE's position regarding subsurface heterogeneity and the application of the equivalent homogeneous media. Note also, that the vadose zone hydraulic properties for the homogenous units are treated with uncertainty by scaling the Darcy flow and moisture content using an abstraction developed from different STOMP analyses.

- *"The inclusion of moisture-dependent anisotropy functions allows the homogeneous HSUs to adequately approximate the effects of heterogeneity" may not necessarily*

address of flow and transport required for complete analysis not only for the residuals but also for the past leaks. Ecology has provided a number of comments on this subject during the C-Tank Farm PA analysis. DG

Response: See response to HCR4-1 on DOE's position regarding subsurface heterogeneity and the application of the equivalent homogeneous media and the additional information provided in the response to bullet 1 in this comment.

HCR3-4. Section 3.2.3, p. 3-49, lines 4-9. For the tap water scenario that Ecology may use as a line of evidence in addition to WAC 173-340-720, the exposure pathways given here do not include immersion in tap water, which was given for WMA C, in RPP-ENV-58806, Section 7.2.3, p. 7-39. This document should be corrected to be consistent with the WMA C document. BR

USDOE Disposition 7/9/21

Response: Unclear. Unable to find immersion in tapwater discussion in RPP-ENV-58806, Section 7.2.3, p. 7-39 (or anywhere else in that document)

Ecology response 9/14/21: This page citation is incorrect for this document. See p. ES-7 (last bullet) and Figure 7-1 of RPP-ENV-58806.

HCR4-1. Section 4.1.1.1, p. 4-2, lines 14-19: According to the text "the EHM model representation does capture the mean or the bulk flow characteristics of the vadose zone moisture plumes (RPP-RPT-60101; Simulating field-scale moisture flow using a combined power-averaging and tensorial connectivity-tortuosity approach" [Zhang and Khaleel 2010]; and "Estimation of effective unsaturated hydraulic conductivity tensor using spatial moments of observed moisture plume" [Yeh et al. 2005])." Ecology expects USDOE to take similar C-Tank Farm approach to address small scale heterogeneity based on geology, hydrogeologic charateristics (e.g. moisture content, etc.). DG

USDOE Disposition 7/9/21

Response: While the hydrogeologic framework at WMA A-AX is slightly different than hydrogeologic conditions at WMA C, both of these areas share some common characteristics that make some of the previous work done at WMA C very applicable to conditions at WMA A-AX. In particular, both areas contain thick sequences of sand-dominated hydrostratigraphic units that contain the presence of thin fine-grained layers that have elevated moisture contents relative to the overall average moisture contents found in the sand facies of these units. The effect of these thin fine-grained units with elevated moisture content on flow and transport through the vadose zone was the focus of a number of detailed analysis at WMA C that are very relevant to WMA A-AX.
Although the WMA C subsurface does not include a several-foot-thick layer of CCUz above the water table, the preliminary WMA A-AX models do include the CCUz layer as an EHM based on the findings from the work performed for WMA C.
Conceptual models that explicitly represented these types of vadose zone heterogeneities in major HSUs beneath WMA C were evaluated in much detail and sought to understand the potential effects of heterogeneities on flow and contaminant transport at WMA C that included:

- *A summary of previous work by PNNL documented in PNNL-24740, Alternative Conceptual Models of the Subsurface at WMA C;*
- *A summary of previous work by WRPS, PNNL, and INTERA, Inc. (INTERA) that is in the process of being documented in RPP-RPT-61239, Multiple Lines of Evidence and Modeling Results for Heterogeneous Alternative Conceptual Models of the Subsurface at Waste Management Area C, in preparation; and*
- *A summary of recent work by WRPS and INTERA completed at the request of Ecology and documented in Section 5 and Appendix B of RPP-RPT-59197.*

The last body of work where we worked very closely with Ecology to address their specific areas of concerns related to the effect of subsurface heterogeneities on flow and transport is particularly noteworthy. This scope involved multiple simulations of a cross-sectional model that evaluated the effect of thin fine-grained high moisture layers based in interpretations by the Nez Perce in the sand-dominated sequence on a leak from tank C-105. This specific past leak consisted of a 5-year release from 1963 to 1968 of a 20,500 gal waste volume containing ~10 Ci of ^{99}Tc to the upper part of the vadose zone between the tank 241-C-104 and tank C-105. All aspects of the conceptual model including the selection of hydraulic properties for the fine-grained units were specified by Ecology staff.

General observations from the range of simulation cases examined in this generic study of the heterogeneity at WMA C with Ecology staff were as follows.

- *The movement of the center of mass of the simulated plumes was generally vertically downward below the source for all simulations, including those that incorporated the alternative thin finegrained units.*
- *All simulations that incorporated alternative heterogeneity produced additional plume spreading over what was produced in simulation using the EHM model(s). The spreading resulted in a broadening of the fringes of the plume, resulting in a wider region of low concentration, but lower peak concentrations associated with the center of mass of the plume.*
- *The EHM representation of the vadose zone generally produced higher peak mass flux and an earlier occurrence of peak fluxes at the water table compared to all analyses incorporating additional alternative interpretation of heterogeneity.*

The results produced in this modeling evaluation of heterogeneity with Ecology was generally consistent with results produced in the other two studies. The other studies were based on examining the effect of other alternative conceptual models of subsurface heterogeneities of both past leaks and tank residuals using more detailed three-dimensional modeling. In these other studies, the EHM representation of the vadose zone generally produced the least amount of plume spreading and higher peak mass flux at the water table compared to all other analyses incorporating additional alternative interpretation of heterogeneity.

It is DOE's position that the detailed analyses of the effect of subsurface heterogeneity performed at WMA C is very applicable to conditions at WMA A-AX and that a detailed reanalysis of the effects of these types of heterogeneities in the vadose this time and would serve only to confirm the general results of the modeling studies that were produced at WMA C.

Ecology Response 9/23/21: Disposition not accepted for WMA A-AX. Ecology requests a meeting to discuss this issue.

HCR4-2. Section 4.2. 1.2, p. 4-8: Specifically what is the needed characterization?

USDOE Disposition 7/9/21
Response: Accepted. The native file has been edited to say: "As mentioned in Section 3.2.1, due to the lack of characterization data on WMA A-AX residual waste because there are no post-retrieval sample results to draw from. It is fully intended that future iterations of the WMA A-AX impacts analysis will reassess inventory and source term release based on future post-retrieval sampling."

Ecology Response 9/15/21: Disposition accepted, pending revision.

What is uncertainty of using WMA-C data for residual waste? JWY

USDOE Disposition 7/9/21
Response: In the absence of specific waste analyses, diffusion through the waste to the tank base mat is simulated without any physical or chemical process that retains COPCs in the waste. The exception is for uranium and chromium, which are constrained by a solubility limit developed from WMA C waste. The applicability of using waste information from WMA C is addressed by including uncertainty on these values in the preliminary WMA A-AX PA and RCRA Impacts Analysis. Uncertainty on the solubility values were included in the uncertainty analysis using a solubility multiplier that adjusted the reference case solubilities for uranium and chromium by 50% to 200%. The uncertainty analysis sampled the solubility multiplier independently for uranium and chromium.

Ecology Response 9/16/21: Ensure reassessment of WMA- AX data is included in the PA maintenance plan for PA updating and tracking.

HCR4-3. Section 4.2.3.5, Figure 4-15, p. 4-60: This figure shows plenty of variation in the points of calculation and flow velocity distribution in the WMA A-AX three-dimensional process model. Please include an explanation for this in the text. DG

USDOE Disposition 7/9/21
Response: Accepted. The following text has been added to the end of 4.2.3.6 to explain the variation in flow velocity: "The process model includes the different aquifer HSUs that produce variance in the Darcy velocities at the water table. The development of the system model in GoldSim© involved matching the process model breakthrough curves thereby incorporating the variance in the Darcy velocities along a flow line."

Ecology Response 9/27/21: Disposition accepted, pending revision.

HCR4-4. Sections 4.2.3.7 and 4.2.3.8, p. 4-57. Is the 100m value which is used to calculate the risk based on the comingled nitrate value? JWY

USDOE Disposition 7/9/21

Response: Accepted. The following text has been added to the discussion: "Because the centers of mass from the two plumes do not commingle, peak concentration results at the 100-m boundary are taken from the PoCal intersecting the center of the plume originating from A farm."

Ecology Response 9/15/21: Disposition accepted, pending revision.

HCR4-5. Section 4.2.4, p. 4-72, Depending on where the POC is it looks like comingling of down gradient A with AX could affect the concentration especially for Tc-99 as shown on figure 4-17. Please discuss. JWY

USDOE Disposition 7/9/21

Response: Accepted. The text will be revised to include a discussion of comingling plumes and how the peak results reported in the PA and RCRA Impacts Analysis from each tank farm maybe impacted by one another. The text on page 1-23 "Total concentrations for sources in A Farm are calculated separately from sources in AX Farm because center of the plumes from the tank farms sources do not overlap." Will be augmented with more details.

Comingling of the plumes from A and AX Tanks Farms is likely as is shown in RPP-ENV-62206 Figure 4-17. However, there is minimal, if any, comingling of the plumes at the points of calculation evaluated in the PA and RCRA Impacts Analysis. The points of calculation in these documents is the downgradient location at the tank farm fence line and 100-meters beyond the fence line. In addition, the point of calculation is the location at these distances that has the highest plume concentration from all the sources. Separate points of calculation were reported for each tank farm separately and only included the sources from applicable tank farm, thereby excluding comingling. With regards to the entire WMA, the peak impact from the entire WMA would only be different from the peak impact from one of the farms if there was comingling of plumes that led to higher concentrations at the fence line or 100-m from the fence line. However, as illustrated in Figure 4-17, this doesn't appear to be the case.
For A-Farm, the AX-Farm plumes in Figure 4-17 show minimal overlap to the A-Farm plume along the flow line that has the highest plume concentration (which is nearly immediately downgradient of A-104 and A-105, any flowing parallel to releases from sources in AX-Farm). From the legend, the AX-Farm plume may be a factor of ten or more lower than the A-Farm plume at these points of calculation. Further downgradient both plumes are diluted and have lower concentrations than at the points of calculation even though there may be more plume comingling. Figure 4-17 indicates that the AX-Farm plume has minimal co-mingling at the AXFarm fence line, but more comingling of sources further downgradient. However, the legend colors indicate that the plume downgradient of AX-Farm at the 100-meter point of calculation is less than the plume from A-Farm at the 100-m point of calculation. Therefore, comingling of plumes do not

significantly contribute to the WMA A-AX plume concentration at the points of calculation for the A-Farm sources.

Ecology Response 9/15/21: Disposition accepted, pending revision.

HCR4-6. Section 4.2.5, p 4-73, Lines 22-23. Text states, "Given this research, it is highly unlikely that a high percentage of the total chromium inventory impacting groundwater is in the hexavalent form." If incorrect, describe how this assumption may have significant consequences, given the applicability of an IUR for Cr^{+6} (0.084 $[ug/m^3]^{-1}$), as well as an oral CSF for Cr^{+6} (0.5 $[mg/kg/d]^{-1}$), in an EPA tap water scenario (e.g., inhalation while showering, ingestion of groundwater). DD

USDOE Disposition 7/9/21
Response: Partially Accept. See response to HCRES12b.

Ecology response 8/30/21: Disposition accepted for the inhalation/showering pathway for Cr+6 (HCRES12b).

USDOE Disposition 7/9/21
Regarding the oral CSF, no change will be made. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology response 8/30/21: Disposition not accepted for the oral/groundwater ingestion pathway for Cr+6 (see Ecology response to HCRES12c).

HCR4-7. Section 4.2.5.1.1, p. 4-74, Table 4-14. Ecology will assume that the chromium in water is hexavalent chromium in the absence of speciation data for chromium in water. Please add hexavalent chromium to Table 4-14. BR

USDOE Disposition 7/9/21
Response: RPP-ENV-58806 added Cr+3 and Cr+6 to analysis; the next revision of this document will do the same

Ecology Response 9/27/21: Disposition accepted, pending revision.

HCR4-8. Section 4.2.5.1.1, p 4-74, Table 4-14. DD

USDOE has divided this comment into 3 parts (a-c):

a. Note that the oral RfD shown for Cr (1.5 mg/kg/d) is for Cr^{+3}. Please also list oral RfD for Cr^{+6} (3E-3 mg/kg/d) and inhalation RfC for Cr^{+6} (8E-6 mg/m3 for mists/aerosols, 1E-4 mg/m^3 for particulates).

USDOE Disposition 7/9/21
Response: RPP-ENV-58806 added Cr+3 and Cr+6 to analysis; the next revision of this document will do the same

Ecology response 8/30/21: Disposition partially accepted, pending revisions. Please clarify that the RfD shown for Cr (1.5 mg/kg/d) is for Cr+3.

Regarding inhalation: Propose a section titled "Uncertainties Associated with Inhalation of Aerosols Containing Hexavalent Chromium", modeled after DOE/Aerosols Containing Hexavalent Chromium", modeled after DOE/RL-2010-95, which closed a similar comment with modeled after DOE/RL-2010-95, which closed a similar comment with Ecology in 2012.

Ecology response 8/30/21: Disposition accepted, pending revisions.

b. In addition, list the IUR for Cr^{+6} (8.4E-2 $[ug/m^3]^{-1}$) and oral CSF for Cr^{+6} (0.5 $[mg/kg/d]^{-1}$).

USDOE Disposition 7/9/21
Response: Partially accept. See response to HCRES12b.

Ecology response 8/30/21: Disposition accepted for IUR on the basis that Table 4-14 is for noncancer parameters.

Regarding the oral CSF, No change will be made. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology response 8/30/21: Disposition accepted for oral CSF on the basis that Table 4-14 is for noncancer parameters but still request that the oral CSF for Cr+6 (0.5 [mg/kg/d]-1) be used for oral exposures (see Ecology response in HCRES12c).

c. Also, EPA/OSRTI and MTCA/CLARC have adopted a revised oral RfD for U (2E-4 mg/kg-d) (https://semspub.epa.gov/work/HQ/196808.pdf). Please list this revised oral RfD for U, and use it for toxicity calculations. DD

USDOE Disposition 7/9/21
No change will be made. DOE is aware that an oral RfD of 2E-04 mg/kg-day is published by ATSDR. At this time, the oral RfD of 0.003 mg/kg-day listed in IRIS has not been withdrawn. At this time, EPA has not provided specific direction to implement the use of the ATSDR value in Hanford site cleanup decisions.

Ecology response 8/30/21: Disposition not accepted. EPA Region 10 (Marc Stifelman, 9 April 2019 meeting with USDOE/EPA/Ecology, Richland) provided USDOE specific direction to

implement the use of the ATSDR value in Hanford site cleanup decisions. The revised RfD for U (2E-4 mg/kg-d), based on an ATSDR MRL, clearly represents more defensible science than the older IRIS RfD (3E-3 mg/kg-d), as evidenced by its adoption by many EPA offices (EPA Region 10, EPA/OSRTI, EPA RSL tables), as well as Ecology (in MTCA/CLARC guidance). Continued use of the older outdated RfD is inconsistent with a policy based on use of best available science.

HCR5-1. Section 5.1, p. 5-2, lines 1-7. The text states "Chemicals in the pipeline/ancillary equipment, with no grout and concrete barriers, are released through advection and diffusion. The advective release is controlled by the recharge rates in the tank farms. The recharge rate in the first 500 years after closure is 0.5 mm/y to account for the surface barrier." However, the current recharge rate is estimated at about 100 mm/y, and advection associated with the pipeline residuals to is likely to be occurring now. Please add text to justify assuming that release only occurs after a barrier, currently not present, degrades in 500 y. Further, if releases are occurring now, measuring release rates could be used to validate release mechanism models. BR, SVV

USDOE Disposition 7/9/21

Response: RPP-ENV-62206 is a preliminary version of the performance assessment for RCRA constituents required by HFFACO Appendix I the performance assessment for RCRA constituents required by HFFACO Appendix I. The description of the closure conditions are protective of human health and the environment for all contaminants of closure conditions a barrier over the WMA.

The analysis is a post-closure analysis of landfill closure of WMA A-AX. For this assessment, rather than include models to evaluate the corrosion rates and justify them for the pipelines, this analysis adopts the approach that the integrity of the pipeline is intact up to the time of closure and is instantly compromised at the time of closure and no longer protects the residual waste. There are numerous studies that show waste transfer lines are presently intact (RPP-RPT-49200 Direct Assessment of 241-SY Pipelines SN-285 and SN-286. RPP-RPT-47901, 2010, Direct Assessment of 241-AP Farm Lines SL-509, SL-510, SN-609, and SN-610). The timing of when the pipelines corrode to the point that they no longer contain the waste was not evaluated for the analysis, because in this post-closure analysis assuming that time of initiation and complete corrosion is the time of closure allows DOE to evaluate the condition that should lead to the highest impact to groundwater and members of the public in the future. Under this scenario, the waste inventory in the pipelines is not reduced by past releases, which maximizes the inventory in this source term when the simulated releases begin to occur. Evaluating evidence of present day corrosion on pipelines, such as net infiltration getting into the pipelines, leading to a present day release is outside the scope of the assessment, which is a post-closure analysis. Evaluating evidence of present day corrosion on pipelines, such as net infiltration getting into the pipelines, leading to a present day release is outside the scope of the assessment, which is a post-closure analysis.

Furthermore, simulating releases prior to closure is out of scope of this residuals analysis and is the topic of other volumes of the Appendix I closure analyses. NOTE: for

post-closure conditions, releases from pipelines begin at closure but are under an intact barrier that reduces net infiltration to 0.5 mm/yr, after the barrier degrades at 500 years the infiltration rate increases back to natural recharge (3.5 mm/yr).

Ecology Response 9/16/21: Disposition not accepted. The comment requested text and it appears that the requested text will not be added. Furthermore, the disposition states "*The timing of when the pipelines corrode to the point that they no longer contain the waste was not evaluated for the analysis, because in this post-closure analysis assuming that time of initiation and complete corrosion is the time of closure allows DOE to evaluate the condition that should lead to the highest impact to groundwater and members of the public in the future."* There is no demonstration that immediate corrosion after application of a barrier (with an assumed very low recharge rate) would be the highest impact scenario. Currently the pipelines are only under a gravel cover with high recharge, and there is no text indicating that there has been a visual inspection of the WMA A-AX pipelines to determine their condition, so current conditions may result in the highest impact. Due to uncertainty, Ecology will use WAC 174-340 soil concentrations to protect groundwater as a basis to determine if the pipeline residuals are a potential threat to groundwater or not. It is likely that the estimated contaminant concentrations in the pipelines exceed WAC 174-340 soil concentrations to protect groundwater, as the WAC 174-340 soil direct contact concentrations are exceeded for many of the contaminant concentration estimates (comment HCRA-1); WAC 173-340 soil direct contact concentrations are typically less stringent than WAC 174-340 soil concentrations to protect groundwater.

HCR5-2. Section 5.2, p.5-4: Based on table 5-1 values the only concentrations that look certain are the Nitrate and Nitrite values show for 100-1000 year time frame. What is the uncertainty in these values when used in concentration ratios? JWY

USDOE Disposition 7/9/21

Response: It is not clear why the commenter states "Based on table 5-1 values, the only concentrations that look certain are the Nitrate and Nitrite values shown for 100-1000 year time frame." Table 5-1 includes results from a deterministic analysis. All values reported in the table are the simulated results using fixed parameter values for model inputs. Although nitrate and nitrite were included in the uncertainty analysis documented in Section 6 of RPP-ENV-61497, the published results for nitrate only include uncertainty results for cumulative releases to the saturated zone, the uncertainty in the groundwater concentrations (peak and as a function of time) was computed but not included as a result to save. Therefore, the uncertainty in the nitrate and nitrite groundwater concentrations cannot be added to this response.

Regarding nitrate / nitrite concentration ratios, nitrate and nitrite are transported with the same properties. Therefore, the simulations will show that the peak groundwater concentrations for nitrite and nitrate from each source will scale in proportion to their initial inventory. The concentration ratio would change according to the relative changes in the initial inventory. However, because the inventories are different in each tank farm source, the peak concentrations in the groundwater from a collection of sources, such as a tank farm, may not vary in proportion to the total inventory.

Ecology Response 9/15/21: Disposition accepted.

HCR5-3. Section 5.2, p. 5-9 – 5-10, Tables 5-1 and 5-2, and throughout the document: Ecology will use WAC 173-340-720 to set groundwater standards. State and federal laws are all considered in this regulation. Specific values are given in a prior comment on Table 1-3 for the contaminants in Tables 5-1 and 5-2. BR

USDOE Disposition 7/9/21

Response: Accepted. The native files for the next revision of this document have been edited to include tabulation and comparison to MTCA Method A and Method B (noncancer) limits reported in the February 2021 update to CLARC, which was downloaded from https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contaminationclean-up-tools/CLARC/Data-tables on May 3, 2021.

Ecology Response 9/20/21: Disposition partially accepted. Ecology will treat nonradionuclides that are carcinogenic as carcinogens where that would dictate lower cleanup levels, and we will use the lowest cleanup level required by WAC 173-340, following the process in the regulation. We will need to see the values used in your revised version of this document.

HCR5-4(1). Section 5.2, p 5-9 and 5-10, Tables 5-1 and 5-2: DD

USDOE has divided this comment into 2 parts (a & b):

a. Cr^{+6} (4.8E1 ug/L with oral RfD=3E-3 mg/kg/d; 0.2 ug/L with NJDEP/CalEPA oral CSF=0.5 $[mg/kg/d]^{-1}$).

USDOE Disposition 7/9/21

Response: Partially accepted. RPP-ENV-58806 added Cr+3 and Cr+6 to analysis; the next revision of this document will do same.

Ecology response 8/30/21: Disposition accepted, pending revision of RPP-ENV-62206, Rev 0.

Regarding the oral CSF, No change. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology Response 8/30/21: Disposition not accepted. For Cr+6, RPP-ENV-58813 conflicts with EPA guidance (OSWER 9285.7-53 [https://nepis.epa.gov/Exe/ZyPDF.cgi/91015CKS.PDF?Dockey=91015CKS.PDF] and OSWER 9285.7-86, [https://www.epa.gov/sites/default/files/2015-11/documents/tier3-toxicityvalue-whitepaper.pdf]). Together, these two OSWER guidance documents consider the oral CSF for Cr+6, as a valid EPA Tier 3 toxicity value, as described in the comment.

b. In addition, provide references for Kd values in sand. The Kd for Cr (0 mL/g) appears to be the Hanford Kd value for Cr^{+6}, while the MCL for Cr (0.1 mg/L) is for total Cr. In the absence of Cr speciation data, Cr should be assumed to be Cr^{+6} for risk evaluation. DD

USDOE Disposition 7/9/21
Response: The transport calculations are performed assuming all of the Cr is mobile in the environment like that of chromium in a hexavalent state (Cr+6) in the subsurface (Kd = 0 ml/g). The next revision of this document will include table entries for total chromium and Cr+3.

Ecology Response 8/30/21: Disposition accepted, pending revisions, including the MCL for total Cr (0.1 mg/L).

HCR5-4(2). Section 5.2.1, p 5-12, Line 1: Specify that Kd=0 mL/g for Cr+6 (not "chromium"). DD

USDOE Disposition 7/9/21
Response: Accepted. A footnote will be added stating "The Kd used for chromium in this analysis comes from PNNL-17154, which only explicitly reported results for hexavalent chromium. Since the value used is 0 mL/g, it can be considered a conservative mobile version of Cr. That is consistent the mobility of hexavalent chromium."

Ecology Response 8/30/21: Disposition accepted.

HCR5-6. Section 5.3.1, p 5-24, Lines 28-34. DD

USDOE has divided this comment into 2 parts (a & b).

a. Cancer risks presented here should specify an inhalation pathway (assuming that is the case).

USDOE Disposition 7/9/21
See response to HCRES12b.

Ecology response 8/30/21: Disposition not accepted. Specify a shower scenario and an inhalation pathway here (Section 5.3.1).

b. In addition, please specify ingestion cancer risks, using the oral CSF for Cr^{+6} (0.5 $[mg/kg/d]^{-1}$). DD

USDOE Disposition 7/9/21
Response: No change. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology Response 8/30/21: Disposition not accepted. For Cr+6, RPP-ENV-58813 conflicts with EPA guidance (OSWER 9285.7-53 [https://nepis.epa.gov/Exe/ZyPDF.cgi/91015CKS.PDF?Dockey=91015CKS.PDF] and OSWER 9285.7-86, [https://www.epa.gov/sites/default/files/2015-11/documents/tier3-toxicityvalue-whitepaper.pdf]). Together, these two OSWER guidance documents consider the oral CSF for Cr+6, as a valid EPA Tier 3 toxicity value, as described in the comment.

HCR5-7. Sections 5.3.3 and 5.3.4, p 5-39, Lines 4-10. DD

USDOE has divided this comment into 3 parts (a-c).

a. Although text states, "…there is no hazard from the inhalation pathway," total Cr should be assumed to be Cr^{+6} (due to absence of Cr speciation data) which results in hazard and risk from inhalation.

USDOE Disposition 7/9/21
Accepted. RPP-ENV-58806 added Cr+3 and Cr+6 to analysis; The next revision of this document will do same. In addition, the next revision will say that our inventory for Cr is total chromium. In the tabular results (Table 5-5 and 5-6 where Cr is presented will be updated to include a footnote indicating that the HQ provided assumes that Cr is total chromium and give an alternative HQ if all Cr is assumed to be Cr+6.
The comparison against the MTCA GW CUL will be updated to compare against all three (Total Cr, Cr+3, and Cr+6) limits with appropriate footnotes.

Ecology response 8/30/21: Accepted, pending revisions. In your proposed footnote (all Cr is assumed to be Cr+6), this will produce an alternative HQ (as you note), as well as a cancer risk, due to inhalation (and ingestion) of Cr+6.

b. That is, the inhalation RfC for Cr^{+6} mists/aerosols (8E-6 mg/m^3), as well as the IUR for Cr^{+6} (8.4E-2 $[ug/m^3]^{-1}$), should be used to estimate respective noncancer HQ and cancer risk from inhalation (e.g., showering pathway, https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=525385&Lab=NHSRC; https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0168051&type=printable; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2874882/pdf/nihms68723.pdf).

USDOE Disposition 7/9/21
Response: See response to HCRES12b.

Ecology response 8/30/21: Not accepted. The USDOE response to comment HCRES12b describes the single study by Finley et al. (1996). That study is now 25 years old. The EPA model (TEVA-SPOT), described in the comment, is more recent and presumably reflects improvements for modeling inhalation of VOCs and aerosol particles (e.g., Cr+6) during

showering. The TEVA-SPOT User's Manual was published in Sept 2017 (https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=342589&Lab=NHSRC), along with a companion document (https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NHSRC&direntryid=323510&keyword=homeland%20security&subject=homeland%20security%20research&showcriteria=2&fed_org_id=111&datebeginpublishedpresented=10/24/2011&dateendpublishedpresented=10/24/2016&sortby=pubdateyear). Please consider this EPA methodology.

c. In addition, the oral RfD for Cr^{+6} (3E-3 mg/kg/d) and oral CSF for Cr^{+6} (0.5 $[mg/kg/d]^{-1}$) should be used to estimate respective noncancer HQ and cancer risk from groundwater ingestion. DD

USDOE Disposition 7/9/21

Response: No change. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology response 8/30/21: Disposition not accepted. For Cr+6, RPP-ENV-58813 conflicts with EPA guidance (OSWER 9285.7-53 [https://nepis.epa.gov/Exe/ZyPDF.cgi/91015CKS.PDF?Dockey=91015CKS.PDF] and OSWER 9285.7-86, [https://www.epa.gov/sites/default/files/2015-11/documents/tier3-toxicityvalue-whitepaper.pdf]). Together, these two OSWER guidance documents consider the oral CSF for Cr+6, as a valid EPA Tier 3 toxicity value, as described in the comment.

HCR6-1. Section 6.0, p 6-1, Lines 21-30. Text states, "A probabilistic analysis of the base case to show the effects of parameter uncertainty on the performance of the system for hazardous chemicals was not performed in this analysis because it is not specifically required." Text goes on to say that this analysis was performed for rads in the DOE O 435.1 PA. Therefore, describe rationale for omitting this analysis for nonrads, while including it for rads (in terms of information value, rather than regulatory requirement). DD

USDOE Disposition 7/9/21

Response: The probabilistic analysis was omitted because of Ecology's policies about probabilistic analysis (WAC 173-340-708, "Human Health Risk Assessment Procedures"). The framework for interpretation of probabilistic analyses is unclear under RCRA and MTCA. The probabilistic analysis of Radionuclides was performed in the WMA A-AX PA because DOE O 435.1 allows for probabilistic analyses. This rationale was described in section 3.1 of this document.

Ecology response 8/30/21: Disposition accepted. MTCA (WAC 173-340-708 [11]) allows probabilistic analysis for information purposes but not as rationale to replace CULs. It would be more consistent to assess rads and nonrads similarly in terms of probabilistic assessment (at least for information value)

HCR6-2. Section 6.2, p 6-5, Lines 21-23. Text states, “The sensitivity analyses quantify the ranges of calculated groundwater concentration outcomes due to single-parameter or multiple-parameter changes that represent an underlying shift in the conceptual model.” However, these sensitivity cases (Table 6-1) appear limited to the effect of single parameter changes on peak groundwater concentration/time. As such, these analyses (which change one factor at a time) are useful in isolating the effect of a single parameter on the output but cannot detect interactions among multiple parameters which may be critical to understanding the system. DD

USDOE Disposition 7/9/21

Response: The sensitivity analyses evaluate the effect of a single parameter change and cascade the consequences of that change where interactions are known to occur in accordance with the conceptual model. Generally speaking, models can only simulate known interactions because the models have to be set up to include the interactions. The degenerate case of this kind of multiple interaction analysis is an uncertainty analysis that includes uncertainty in key parameters but samples them completely independently from the uncertainty in all other parameters. The sensitivity cases, together with the uncertainty analysis and importance analysis described in RPP-ENV-61497 Sections 6.1, are all used to demonstrate that the models produce results that are consistent with a fundamental understanding of fate and transport processes.

Ecology response 8/30/21: The sensitivity analysis in this document appears to be a one at a time (OAT) approach, where a single input parameter is varied to observe the effect on model output (e.g., groundwater concentration). As such, the cited statement remains problematic, because multiple input parameters are not varied simultaneously. Please delete “multiple parameter changes” in the cited statement. Although probabilistic uncertainty analysis (e.g., Monte Carlo) addresses multiple input parameters simultaneously, probabilistic analysis was performed outside of the suite of sensitivity cases and only for rads in RPP-ENV-61497.

HCR6-3. Section 6.2.1 p. 6-7 3rd bullet. What does “extraneous analysis” mean in this context? JWY

USDOE Disposition 7/9/21

Response: Accepted. The sentence will be modified to say: "Analysis cases that do not pertain to specific safety functions have been dropped."

Ecology response 9/13/21: Disposition Accepted.

HCR6-4. Section 6.2.7, p 6-32, Lines 19-22. The Kd for Pb at Hanford should be 30 mL/g (Ames and Serne, 1991, PNL-7660, cited in ECF-Hanford-10-0442, Rev 1). DD

USDOE Disposition 7/9/21

Response: No Change. Changing the Kd would not provide different results. Site-specific distribution coefficients (see Appendix E) were used to approximate the transport of lead through the vadose zone

Ecology response 8/30/21: Disposition Accepted.

HCR8-1. Section 8.1.1.1, p 8-3, footnote 1. DD

USDOE divided this comment into 2 parts (a & b)

a. Cancer risks presented here should specify an inhalation pathway (assuming that is the case).

USDOE Disposition 7/9/21
Response: See response to HCRES12b.

Ecology response 8/30/21: Disposition not accepted. Specify a shower scenario and inhalation as the pathway assessed in this footnote here (Section 8.1.1.1).

b. In addition, please specify ingestion cancer risks, using the oral CSF for Cr+6 (0.5 [mg/kg/d]-1). DD

USDOE Disposition 7/9/21
Response: No change. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.
Ecology response 8/30/21: Disposition not accepted. For Cr+6, RPP-ENV-58813 conflicts with EPA guidance (OSWER 9285.7-53 [https://nepis.epa.gov/Exe/ZyPDF.cgi/91015CKS.PDF?Dockey=91015CKS.PDF] and OSWER 9285.7-86, [https://www.epa.gov/sites/default/files/2015-11/documents/tier3-toxicityvalue-whitepaper.pdf]). Together, these two OSWER guidance documents consider the oral CSF for Cr+6, as a valid EPA Tier 3 toxicity value, as described in the comment.

HCR8-2. Section 8.1.1, p 8-4 to 8-5, Tables 8-1 and 8-2. DD

USDOE divided this comment into 2 parts (a & b)

a. The table footnotes (indicated by *) should specify both oral

USDOE Disposition 7/9/21
Response: See response to HCRES12b.

Ecology response 8/30/21: Disposition not accepted. The USDOE response (HCRES12b) refers to the Finley et al (1996) study which only evaluated cancer risk to inhalation of Cr+6 (showering scenario). Finley et al (1996) did not evaluate noncancer exposure to Cr+6. As such, clarify if HQ (in footnotes to Table 8-1 [HQ=0.21] and Table 8-2 [0.054]) includes both oral (RfD=3E-3 mg/kg/d) and inhalation (RfC [mists/aerosols]=8E-6 mg/m^3) noncancer effects. These are separate from oral and inhalation cancer risks.

b. and inhalation and pathways for HI for Cr+6 (assuming that is the case). DD

USDOE Disposition 7/9/21
Response: No change. The toxicity values used for the hazardous substances evaluated in this ECF are consistent with RPP-ENV-58813, Exposure Scenarios for Risk and Performance Assessments in Tank Farms at the Hanford Site, Washington.

Ecology response 8/30/21: Disposition not accepted. Clarify if HQ (in footnotes to Table 8-1 [HQ=0.21] and Table 8-2 [0.054]) includes both oral (RfD=3E-3 mg/kg/d) and inhalation (RfC [mists/aerosols]=8E-6 mg/m^3) noncancer effects. These are separate from oral and inhalation cancer risks.

HCR8-3. Section 8.1.1.2, p 8-3, Lines 32-39. Contrary to text, U does appear to contribute to HI at peak yr (10000 yrs after closure) at both tank farms (Tables 8-1 and 8-2). Please correct text. DD

USDOE Disposition 7/9/21
Response: Accept. Text is unclear. Native files have been modified to specify that Uranium does not contribute to the Hazard Index at the year of peak Hazard Index, which is 2120. Uranium does contribute to the Hazard index, but later in the simulation, not at 2120.

Ecology response 8/30/21: Disposition accepted.

HCR8-4. Section 8.1.2, p 8-4, Lines 5-13. Clarify why radionuclides are discussed here in this document on hazardous chemicals (nonrads). DD

USDOE Disposition 7/9/21
Response: Accepted. The text has been removed in the native file.

Ecology response 8/30/21: Disposition accepted, pending revision.

HCR8-5. Section 8.1.2, p 8-6, Tables 8-3 and 8-4. The MCL for nitrite (as nitrite) is 3.3 mg/L (not 4.5 mg/L). Please correct. DD

USDOE Disposition 7/9/21
Response: Accepted. The text in the native file has been corrected.

Ecology response 8/30/21: Disposition accepted, pending revision.

HCR8-6. Section 8.2, p 8-5, Lines 15-17. Text states, “Sensitivity analyses are generally intended to evaluate the effects of scenario and conceptual model uncertainties on the groundwater concentrations at the PoCals used in the impacts analysis.” As used here (Table 8-5), sensitivity

analyses appear to evaluate effects of parameter uncertainty (parameter changes), not model uncertainty (e.g., alternative transport models). Please clarify. DD

USDOE Disposition 7/9/21

Response: Alternate conceptual models are considered in the sensitivity analysis. While some sensitivity cases due evaluate "parameter sensitivity" due to uncertainty (such and inventory cases), other cases do evaluate alternative conceptual models such as: post-closure condition where there is no surface barrier or the tank structure provides a reduce function to divert water from the residual waste. Parameter uncertainty is addressed through the uncertainty analysis on nitrate and select radionuclides documented in RPP-ENV-61497 Section 6.1.

Ecology response 8/30/21: Disposition partly accepted. Nitrate/nitrite issue not addressed. With respect to sensitivity and uncertainty analyses, Ecology would recommend using terminology consistent with NCRP Commentary No. 14 ("A Guide for Uncertainty Analysis in Dose and Risk Assessments Related to Environmental Contamination"). Uncertainty analysis is divided into parameter uncertainty and model uncertainty. Sensitivity analysis can be used to determine parameters with the largest effect on total uncertainty. Also, the USDOE response identifies nitrate as the contaminant used to illustrate parameter uncertainty. However, it looks like the selected contaminant for this use is nitrite (Table 8-5).

HCR8-7. Section 8.2, p 8-10, Lines 3-5. Sensitivity analysis (Table 8-5) does not appear to evaluate simultaneous changes in multiple parameters (e.g., varying both INF and INV together) on groundwater concentration/peak arrival times. As such, please acknowledge that parameter interactions are not evaluated, highlighting an additional source of parameter uncertainty. DD

USDOE Disposition 7/9/21

Response: Parameter uncertainty is addressed through the uncertainty analysis on nitrate and select radionuclides documented in RPP-ENV-61497 Section 6.1. This assessment was not pulled into this document. The uncertainty analysis documented in RPP-ENV-61497 Section 6.1 is a degenerate case of a multiple interaction analysis. This uncertainty analysis included uncertainty in key parameters but sampled them completely independently from the uncertainty in all other parameters. When a sufficient number of realizations are performed, the outcomes include cases where interactions among uncertain parameters align with consequences of known or unknown interactions.

Ecology response 8/30/21: Disposition not accepted. The USDOE response notes, "The uncertainty analysis documented in RPP-ENV-61497 Section 6.1 is a degenerate case of a multiple interaction analysis." This does not address the Ecology comment for RPP-ENV-62206. Although probabilistic uncertainty analysis for rads in RPP-ENV-61497 (e.g., Monte Carlo) addresses multiple input parameters simultaneously, probabilistic analysis was performed outside of the suite of sensitivity cases and not in RPP-ENV-62206.

USDOE Disposition 7/9/21

The uncertainty analysis documented in RPP-ENV-61497 Section 6.1 was not pulled into this document because Washington Administrative Code (WAC 173-340-700 Cleanup Standards), which is referred to in WAC 173-303-610 Closure and Post-Closure [of all dangerous waste facilities] states that similar analyses for Human Health Risk Assessments in WAC 173-340-708(11) are for information only and that "Such methods shall not be used to replace cleanup standards and remediation levels derived using deterministic methods under this chapter until the department has adopted rules describing adequate technical protocols and policies for the use of probabilistic risk assessment under this chapter."

Ecology response 8/30/21: Disposition not accepted. Because WAC 173-340-708 [11] allows probabilistic analysis for information purposes (albeit not as rationale to replace CULs), inclusion of similar probabilistic analyses (for both RPP-ENV-62206 and RPP-ENV-61497) would add greater consistency to the assessment of rads and nonrads at WMA A-AX.

HCR8-8. Section 8.3, p. 8-10. The document states "Consequently, it can be concluded the retrieval process may be driven by considerations other than post-closure behavior of WMA A-AX." Ecology will need an estimate of risks for all source terms, including the nontank sources in the vadose zone, prior to making closure decisions. BR

USDOE Disposition 7/9/21

Response: The scope of this comment is the not the subject of this document. This document focuses on the human and environmental impacts for waste residuals left in tanks and ancillary equipment. This scope is briefly described in the Preface on p. 1-1 and p. 1-4

Ecology Response 9/14/21: Disposition not accepted. Please delete the quoted statement. It is broader than the stated scope of this document.

HCRA-1. Appendix A, General: The following contaminants that are associated with pipelines, which are within 15 ft of the ground surface, exceed levels of concern for soil. Since the pipelines will not be grouted, they will decompose over time, and the contaminants inside will become part of the soil. In the table below, estimated concentrations inside the pipelines have been compared to WAC 173-340 direct contact and ecological protection levels of concern for soil. The concentrations in the pipelines were calculated as described in Section 6.1 of RPP-RPT-58293, Rev. 1, using summed inventory values for A-farm and AX-farm from Appendix A of RPP-RPT-58293, Rev.1, and averages based on the number of tanks in each farm.

Contaminant	Tank Farm	Exceeded Direct Contact	Exceeded Ecological Protection
Aluminum	A	Yes, Method B	Yes – Plant value
Chromium	A	No	Yes – Wildlife value
Iron	A	Yes, Method B	No
Manganese	A	Yes, Method B	Yes – Plant value

Contaminant	Tank Farm	Exceeded Direct Contact	Exceeded Ecological Protection
Nickel	A	Yes, Method B	Yes – Plant value
Uranium (total)	A	Yes, Method B+C	Yes – Plant value
Aluminum	A-AX	Yes, Method B	Yes – Plant value
Chromium	A-AX	No	Yes – Wildlife value
Iron	A-AX	Yes, Method B	No
Manganese	A-AX	Yes, Method B	Yes – Plant value
Nickel	A-AX	Yes, Method B	Yes – Plant value
Uranium (total)	A-AX	Yes, Method B+C	Yes – Plant value

BR

USDOE Disposition 7/9/21

Response: This assessment is focused on a groundwater impact analysis of hazardous chemicals on residual wastes left in tanks and ancillary equipment at WMA A-AX under these landfill closure conditions. These closure conditions would include filling tanks and some ancillary equipment with grout. Both the residual wastes left in grout-filled SSTs and in ancillary equipment would then be covered by a RCRA-compliant engineered surface barrier that would be limit any direct contact with residual wastes as well as limit the amount of leaching of wastes by infiltrating water into the underlying vadose zone and groundwater.

Potential impacts from human direct contact and ecological protection from contaminated soil and vadose zone sediments will be evaluated in the risk assessment related to those sources in support of the RFI/CMS that will conducted for WMA A-AX.

Ecology Response 9/14/21: Disposition not accepted. The disposition did not address pipelines. If this document does not address pipeline baseline risks, please include pipeline baseline risks in the risk assessment portion of the IPA and point to that portion of the IPA in this document.

HCRA-2. Section A.8.2, p. A-15, lines 19-23. This assumption does not take into account the thicker and more extensive CCUz unit at WMA A-AX. Conclusions that were made on the basis of data from WMA C that does not have a thick aquitard (or at times an aquiclude) may not be appropriate. Lateral spreading may be much more pronounced than assumed from studies at WMA C. JWL

USDOE Disposition 7/9/21

Response: The CCUz unit is included in the models as an equivalent homogenous medium with soil moisture retention parameters described in RPP-ENV-62206 Table 4-2. The average thickness of the CCUz in the 29 boreholes used to develop the geoframework model in the vicinity of WMA A-AX (Table 3-1 in RPP-RPT-60171) is 1.7 meters and ranges from Not Present up to 4.57 m. A layer of CCUz with thicknesses under the different tank farms was included in the WMA A-AX 3-D geogramework model and 3-d STOMP model used to develop flow fields under an intact and degraded surface barrier.

The STOMP output shows an increase in moisture content at nodes elevations that are consistent with the location of the CCUz from approximately 7 vol% in the layer above the CCUz to approximately 20 vol% in the CCUz. Consequences of lateral spreading under postclosure conditions for thin (0.45 m), fine grain units has been evaluated using STOMP models (RPP-CALC-64255) and the results are consistent with expectations that lateral spreading occurs but results in a broadening of the groundwater plume but lower concentrations, including a lower peak concentration that occurs later in time. Based on these observations, the simulated result for a thicker fine-grained unit deeper in the vadose zone (70 – 80 meters below ground surface) would likely introduce more spreading leading to even lower concentrations than encountered with thinner layers and later arrival of the peak concentration.

Ecology Response 9/13/21: Disposition accepted.

HCRA-3. Section A.8.6, p. A-17. "Lateral dispersion in the vadose zone is minimal" may not be a valid assumption. See previous comments for sections 2.1.8, 3.2, and A.8.2. Furthermore, the corrosion of the 3 wells at WMA (that had to be replaced) occurred at the level of the CCUz in each well, most likely due to chloride spreading from the 200-E-286 Ditch. Corrosion is still occurring at WMA A-AX wells and has spread at least as far as 299-E27-14. Well 288-E27-14 is more than 200 meters from the location of the former location of the 200-E-286 Ditch. So, we know that lateral spreading at WMA A-AX has not been limited to 100 meters (or the boundary of the WMA). JWL

USDOE Disposition 7/9/21

Response: See response to previous comment HCRA-2.
Also, as a post-closure analysis, the simulations assume an engineered barrier that lasts up to 500 years will be placed over the residual waste. Flow in the vadose zone underneath a barrier is significantly different than flow through the vadose zone with anthropogenic recharge from discharges to unlined ditches as discussed in the comment. Lateral spreading beneath a closed WMA should not be expected to be the same as lateral spreading that might result from high volume discharges being impeded by a silt layer.

Ecology Response 9/13/21: Disposition accepted.