UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 7
11201 Renner Boulevard
Lenexa, Kansas 66219

APR 25 2017

Mr. Paul V. Rosasco
Project Coordinator
Engineering Management Support, Inc.
25923 Gateway Drive
Golden, Colorado 80401

Dear Mr. Rosasco:

The U.S. Environmental Protection Agency has reviewed the supporting documentation for the Remedial Investigation Addendum, including the following:

- Upper Confidence Limits of the Mean for Areas 1 and 2 (Appendix O) submitted on July 29, 2016
- Fate and Transport Evaluation (Appendix P) submitted on November 2, 2016
- Baseline Risk Assessment (Appendix Q) submitted on October 31, 2016
- Portions of the Estimated Three Dimensional Extent of RIM (geostatistical document) submitted on September 30, 2016

These submittals were developed and submitted to the EPA as supporting documentation for the draft Remedial Investigation Addendum and the draft Final Feasibility Study on behalf of the West Lake Landfill OU-1 Respondents, Cotter Corporation (N.S.L.), Bridgeton Landfill, LLC., Rock Road Industries, Inc., and the U.S. Department of Energy.

The EPA's review of the documents listed above has been supported by and coordinated with the Missouri Department of Natural Resources, the Missouri Department of Health and Human Services, the U.S. Geological Survey, and the U.S. Army Corps of Engineers.

Comments on the majority of the addendum were previously prepared by the EPA, and transmitted to you in a letter dated March 14, 2017. The EPA is providing these supplemental comments to identify questions, comments, and/or concerns related to the documents described above. The EPA's comments on the documents described in the first paragraph above are contained in the three enclosures to this letter. We understand that the Estimated Three Dimensional Extent of RIM (geostatistical document) was originally prepared as a supporting document for the Final Feasibility Study; however, calculations from the geostatistical document were used to determine the distribution of radiologically impacted material in the addendum. Therefore, the EPA's comments on portions of the geostatistical document are also included in the enclosures to this letter. Please note that the agency plans to provide additional comments on the portions of the geostatistical document that relate to volume estimates and related information provided in the Final Feasibility Study.

Based upon the volume and complexity of our comments contained in our letters to you, a meeting has been scheduled between representatives of the EPA and representatives of the Respondents on May 9-10, 2017. The purpose of this meeting is to discuss the Respondents' proposed responses to the enclosed and previously submitted comments. The EPA requests that the parties' technical experts participate in the meeting in order to resolve technical issues as expeditiously as possible. The EPA will work with you to develop an agenda for that meeting that will assist all parties in preparing for and focusing on key changes required to the Remedial Investigation Addendum.

In accordance with the Remedial Investigation/Feasibility Study Administrative Settlement Agreement and Order on Consent, Docket No. VII-93-F-0005, and the Abbreviated Work Plan for Remedial Investigation Addendum and Final Feasibility Study (May 6, 2016), the Respondents shall prepare a revised Remedial Investigation Addendum Report that incorporates the EPA's comments and requested changes from both the March 14, 2017, letter and this comment letter. The revised addendum is due to the EPA on or before June 16, 2017.

In the meantime, if you have any questions or concerns, please contact me by phone at (913) 551-7141 or by e-mail at jump.chris@epa.gov. I look forward to our meeting, and to the finalization of the Remedial Investigation Addendum.

Sincerely,

Christine R. Jump
Remedial Project Manager
Site Remediation Branch
Superfund Division

Enclosures (3)

cc: Mr. Ryan Seabaugh, MDNR

EPA Comments on Fate-and-Transport Evaluation For Radiologically-Impacted Material, West Lake Landfill Operable Unit 1, Bridgeton, Missouri (DRAFT), November 2, 2016 (F&T Report) presented as Appendix P to the Remedial Investigation Addendum (Draft)

The comments provided below fall primarily into two general categories:

1) Additional information that needs to be included and/or clarified to make the report more understandable and transparent, and

2) Inconsistencies, assumptions and/or alternative geochemical or modeling scenarios that could potentially have significant effects on the presented conclusions.

The EPA is requiring the Respondents to evaluate each comment and to discuss in the Fate and Transport Report the potential impact on the modeling outputs and Report conclusions in accordance with the EPA's requests below. Based upon the response to comments, the EPA will determine whether additional modeling is needed for the OU1 remedy decision.

GENERAL COMMENTS

1. One of the Study Objectives listed in Section 1.2 includes evaluating the potential, under current conditions, for the development and migration of landfill pore water containing radionuclides exceeding maximum contaminant levels (MCLs). Please add an objective discussion of the leachability of the Radioactive Impacted Materials (RIM) under current conditions by discussing the concentrations (not percentages) of radionuclides that leached during the various analytical tests conducted, and comparing them to regulatory levels. Please include discussion of the Toxicity Characteristic Leaching Procedure (TCLP) results from testing of the "Cotter samples."

2. The sensitivity analysis of the study is not robust enough. The approach used focused on a relatively narrowly constrained possible outcome by presenting a single-variable "linear" approach. Please utilize a more robust approach considering a wide variety of possible outcomes, using a multi-variate combination approach. The most sensitive variables appear to be:

    - the amount of mineral encapsulated,
    - the amount of total organic carbon (TOC) and dissolved organic carbon (DOC) present, and
    - the ionic strength.

    Given the fact that essentially all the attenuation performed in the model was based on literature values, a strong sensitivity analysis to test the importance of various input parameters within their range of variability is critical and should be used. The input parameters should be expanded to include other parameters or a combination of parameters (i.e., a paired or multivariate approach) to help provide a more realistic understanding of worst-case scenarios. The base-case simulations should be performed either using conservative parameters or reasonable values. The sensitivity analysis should then be used to evaluate the sensitivity of the model to the changes or variations and to identify what other results are possible.

3. The degradation of organic matter can be important over such a long modeling time (18,000 years). The sensitivity analysis showed the importance of organic carbon as an attenuation mechanism. The model shows that all of the existing organic carbon is degraded within the first 100 years for the base case. This is relatively consistent with Kjeldsen et al. (2002), who state that all of the organic carbon is consumed within an unsaturated/uncapped landfill within a few centuries. However, within a saturated landfill the carbon can last for as long as half a million years. The assumption was made in the model that no carbon degradation or dissolution occurs. The text needs to discuss why this assumption is or is not valid at the West Lake Landfill under various conditions (i.e., tight cap, no cap, etc.).

4. Organic carbon partitioning coefficients, molecular weight, and the degradation rates used in the modeling primarily represent general literature values and are not specific to the site. DOC degradation rates ought to be proportional to dissolved oxygen (DO) infiltration with incoming recharge, but this issue does not appear to be addressed in the report. Please add a brief description summarizing the possible range of values typical of these parameters in similar landfill settings and include a discussion as to whether the values used in this evaluation are closer to the median, high end, or low end of the range of typical values. Also include a discussion of the potential ramifications on the modeling of using each of the different values from this range.

5. The use of 100 milligram per liter (mg/L) for the DOC content of the leachate is on the low end for a mature landfill. Lee et al. (2010) provide a range of 137-650 milligrams per liter (mg/L). The laboratory batch testing results may underestimate the DOC leaching which could affect long term projections, since in the landfill the soil moisture will have more time to chemically and biologically react with and dissolve the organics (longer than the laboratory batch leaching time of ~18 hours). Also, the landfill TOC is subjected to wetting/drying cycles, which can affect DOC leaching. A reasonable or conservative value of DOC should be used in a predictive model where site-specific values have not been determined, while the end numbers in the range (137 and 650) should be used for a sensitivity analysis. Although this range is captured within the sensitivity analysis described in the report, the simulations and associated figures in the report should use either conservative or reasonable values instead of the 100 mg/L, which is considered to be low unless proven otherwise. Please discuss in the text the potential ramifications of using a low estimation/assumption for organic carbon degradation.

6. The study has essentially "interpreted" that the landfill is in Stage 5 – "post methanogenesis, oxidative recovery" -- therefore, oxidative conditions are presumed. Other than stating that solid barium sulfate (BaSO4) and iron-oxyhydroxides are present in the vadose zone, and ferric iron in the solid phase, there does not appear to be other actual chemical data used to "confirm" the hypothesized chemical condition (oxidative). However, there are other potential geochemical scenarios discussed below that could exist in the landfill. Please add a discussion of these scenarios to the Report, as well as any available supporting data, regarding the potential effects of incorporating them into or ruling them out of the Fate and Transport (F&T) evaluation.

   If chemical conditions were intermittently alternating between anoxic and oxic, each of the mineral phases listed above could still be present, and that would not exclude the occurrence of intermittent anoxic conditions that could potentially mobilize radium (Ra). Also, ferric iron could be present in biotite and chlorite/clay weathering products, even under anoxic conditions or intermittently variable redox situations. In the laboratory, Fe is released in every extraction step (see Sect 3.6.3) showing that it is widespread in multiple sources. Fe is reactive and in all solid phases has some sequestration capability for uranium (U), thorium (Th), and Ra. Multiple redox conditions are implied as well as numerous sorptive phases. If the amount of adsorptive hydroxide is overestimated, the overestimation would have significant effects on sequestration.

The second paragraph in section 3.3 indicates that low levels of sulfide in RIM samples (non-detect in most RIM samples) are consistent with limited sulfate (SO4) reduction occurring in RIM. However, the limited sulfide found in RIM samples could also be a product of extreme oxic conditions (hot nitric acid [HNO3] and some hydrogen sulfate [H2SO4]) resulting in SO4-rich precipitates after addition of barium carbonate (BaCO3). It is not necessarily a line of evidence indicating a redox condition sustained within the RIM while buried with high-DOC solutions in the landfill. It is unlikely that a large measurable/detectable amount (in weight %) of this SO4-rich precipitate material could be so rapidly reduced in such a short time since its production (~75 years ago) that a large measurable/detectable amount (in weight %) of sulfidic material could be found. BaSO4 is persistent unless sulfate-reducing conditions are continuous and rigorous. Fe can switch back and forth quickly between ferrous and ferric, so if alternative wetting and drying occurs, the ferric iron (Fe+3) will be present. But that does not mean episodes of Fe-reductive anoxia do not occur. Therefore, there could be pulses of Ra release during seasonal anoxic conditions, and anoxia can be easy to establish in organic carbon-bearing wetted soil, so that even BaSO4 can be reduced (Phillips et al., 2001; Matthews et al., 2006; Martin and Akber, 1999; Landa et al.,1991). Furthermore, in the study, the cation exchange capacity (CEC) of soil is assumed to capture Ra as well; however, it is unclear whether the model accounts for the effects of the calcium-rich landfill leachate on the CEC of soil when determining the extent of radium captured. The report should document whether this was considered and included in the modeling.

A pH as low as 2.64 is reported in one of the non-RIM fate and transport samples used to evaluate radionuclide attenuation within the municipal solid waste (MSW). If this is accurate, leaching using a solution with pH that low should dissolve all carbonate phases, make sorption of Ra near zero, and even begin solubilizing Th. If carbonate phases have been mostly removed by early flushing, the pH in the long run should perhaps remain lower than currently modeled. In any event, if there are zones of low pH, such as 2.64, and preferential flow were to occur in those zones, model results would likely be considerably different. Ra is relatively soluble at pH 5 (Szabo et al., 2005).

7. The complexity of the modeling performed is high in terms of the number of mechanisms considered, the assumptions made, and, to some extent the manner in which input parameters were derived. In some cases, there is insufficient discussion or insufficient supporting information provided in the report. For example, the WHAM VII model was used to derive both aqueous and solid phase intrinsic constants; however, there is only a brief discussion in the text regarding how this was done and very little supporting documentation in the corresponding appendix. Appendix G lists the WHAM constants but does not include the intrinsic constants used in PHREEQC or the equations used to obtain them. The appendix should include a full calculation brief showing how the WHAM constants were converted to PHREEQC intrinsic constants for both aqueous and solid phase humic acid.

8. The modeling paradigm appears to be one premised on landfill stability and some sort of steady state. This paradigm needs to be further justified, especially with the in-growth present in specific contaminants at the site. If an assumption of landfill stability is used, a robust sensitivity analysis is

critical. Also, the time from placement of the RIM to the present may not be sufficiently represented in the model.

9. Much of the F&T Report is derived from the RIM composition analysis which produces inputs for the subsequent modeling. The RIM composition determination relies on material identification and allocation, and the report indicates scanning electron microscopy, x-ray diffraction, and other semi-quantitative techniques were used. Please indicate whether any other methods were considered to better quantify the mineral suites; methods such as thermogravimetric analysis (TGA), differential scanning calorimetry (DSC) or differential thermal analysis (DTA). This could be essential to the groundwater model input and outputs. Discuss potential benefits that might be gained by better quantitative identification of the mineral suites in the RIM and non-RIM samples collected.

10. The inputs used in the PHREEQC model should be documented more clearly in the report. Add a table listing all of the PHREEQC input parameters, indicate the values used for the example, and provide the basis using each particular value. This was done partially in Tables 4-2 through 5-5, but some parameters are missing and in some cases more explanation is needed. A table showing the PHREEQC intrinsic constants calculated from the WHAM constants, the barium exchange constant (and source), and any other thermodynamic data should also be added to the ThermoChimie database.

11. Please add the full input files for HELP and WHAM VII to the appendices. Also make it clear that the WHAM VII constants are valid for a given pH and ionic strength. Please clarify whether the constants are valid or conservative when the pH changes within PHREEQC (i.e., whether pH decreases after calcite is consumed).

12. Please add a series of calculation briefs to the appendices showing how each input parameter was calculated. For example, present how moles of humic acid (i.e., m_0) was calculated from the organic carbon content, including the assumptions made (for example, the carbon (C) content of the humic acid of 40%, the fact that the molecular weight cancels out within PHREEQC, etc.).

13. The HELP model was used to generate average (homogeneous) 1-D flow (recharge), but flow through the underlying heterogeneous landfill materials is not homogeneous. Preferential pathways were not considered in the study. The models most likely underestimate the rate of water flow because vertical flow in the landfill materials will be localized along preferential paths and not uniform as currently assumed. Recharge to some model "grids" will be considerably larger while some much smaller. Focused recharge could also increase colloids, transporting Th-230 down preferential pathways, which could then decay to Ra-226 below the original RIM zone and result in Ra-226 being released closer to or at the water table. At a minimum, the limitations of the homogeneous infiltration approach used should be discussed qualitatively in the sensitivity or uncertainty sections. Please add a discussion to the text/conclusions of potential ramifications to the modeling results of not including flow through preferential pathways.

14. The use of the PHREEQC model for unsaturated flow may unrealistically project mineral dissolution rates included in the model. An infiltration rate of 15.5 inches/year in the real system occurs only periodically. By assuming saturated flow conditions within the vadose zone, the 15.5 inches/year occurs as a continuous and constant flow rate over the entire year. Under this assumed flow condition, mineral dissolution and other kinetically-controlled reactions have more time to occur

than within the real system. Please discuss this uniform flow assumption further in the text and explain limitations associated with this approach.

15. Please clearly state in the text that colloidal transport is accounted for in the study because humic acid colloids and dissolved humic acid are both grouped into the dissolved phase and are both transported as such.

16. Please clarify the Sequential Batch Leaching Test (SBLT) objectives, methods and assumptions in the text of relevant sections. Specifically, the presentation of the conversion to the solid phase results is not clear. The leaching test does not appear to have gone far enough to determine depletion from the mineral phase and might need additional analysis for identifying source contribution to the vadose and saturated zones. However, the leaching amounts are still relatively high and potentially significant, as interpreted from this SBLT approach. Even a few percent (%) variability in the solid phase concentrations could make a significant difference in the amount calculated to be leached. The Report acknowledges this issue but it isn't clear whether this variability is evaluated in any way besides the sensitivity analysis, and the sensitivity analysis may not adequately address this variability in the solid phase concentrations.

17. An important deficiency of the fate and transport evaluation was the use of the Synthetic Precipitation Leaching Procedure (SPLP) (EPA Method 1312) which uses a 20:1 liquid to solid (L:S) ratio, and the lack of any attenuation rates. In the report, the L:S for the vadose zone of 0.25:1 was calculated based on a porosity of 0.40. A ration of 20:1 represents an 80X dilution compared to field conditions. The literature study cited in the report to justify the use of the higher L:S ratio (Townsend et al., 2006) found that for many metals SPLP results under-predict pore water concentrations. The calculations of the pore water concentration of TOC using the L:S of 0.25:1 and the similarity of the TOC value from the SPLP analysis does not justify use of the SPLP test. The validity of the SPLP test to simulate pore water is very much parameter-specific, so even if SPLP is valid for TOC, it is not necessarily valid for uranium, thorium, or radium. The EPA has addressed the L:S ratio effects in a recent leaching guidance (EPA Method 1316) which includes L:S ratios of 0.5:1, 1:1, 2:1, 5:1, and 10:1. The use of multiple L:S ratios has many advantages beyond using more realistic L:S ratios. The multiple ratios also often allow the leaching mechanisms to be determined through isotherms.

    In addition, using a leaching solution of 50 mg/L humic acid solution does not adequately mimic field conditions. The pH and alkalinity of this leaching solution are likely very different from field conditions. Methanogenic-phase landfill leachate is not only fairly high in fulvic and humic acids, but also ammonia and alkalinity. Adding 50 mg/L humic acid would likely produce a solution with a pH of about 5 with no bicarbonate alkalinity. Actual landfill leachate has very high bicarbonate alkalinity and is usually supersaturated with carbon dioxide relative to atmospheric values. Carbonate/bicarbonate concentrations have an important impact on radionuclide leaching, particularly for uranium and thorium.

    Please address the potential impacts on the study results based on these considerations.

18. The study may underestimate the release of Ra-226. Please state whether the sensitivity tests for encapsulation include an increase in Ra release from alpha recoil when encapsulation is minimal (Sub Sec 5.6., p. 5-12 bot.). Alpha recoil over time should lead to alpha recoil damage of even insoluble barite crystals, slowly increasing the possible leaching rate. Please specify in the text that

unknowns exist related to how much Th or Ra mass is present in the micro-crystalline barite forms, and how "hot" these barite forms are (i.e., what is their Ra-226 and Th-230 content). The smaller the crystal sizes, the greater the alpha recoil, and the same holds for leachability. It is essentially assumed that these grains are providing the leached radioactivity in the leach tests, but the release rate is expected to increase with time, especially on the 18,000-year scale. Also, TOC that contains significant amounts of sorbed Th-230 will ultimately provide Ra-226 as an alpha recoil mobilized progeny via decay. Alpha recoil must be accounted for in the study and associated narrative. Include a discussion on this effect and discuss any limitations on the conclusions related to this concept.

19. The results of the modeling should include not only radionuclide profiles, but also tables or figures showing the mass of radionuclides attenuated by each mechanism for each COC in the model; for instance, the fraction of the radium attenuated via ion exchange vs via substitution into barite. Also include the amount of radionuclides lost by or created by decay processes.

20. Section 6 provides a general summary of the modeling portions of the study only and does not discuss other important data and findings of the fate and transport sampling and analysis study, such as the leachability of radionuclides under the assumed, simulated and/or modeled conditions. Please revise Section 6 to include clear statements regarding all significant fate and transport findings and conclusions.

21. Appendix P (F&T) files and supporting documents: The fate and transport evaluation was submitted as Appendix P to the Remedial Investigation Addendum (RIA); thus files related to Appendix P and supplied in support of the F&T Report should be titled in a manner to clearly indicate they are associated with Appendix P (e.g., Figure P 1-1, Table P 2-1, or Appendix P-A). Check globally and revise the Table of Contents to reflect this change.

22. Appendices to the F&T Report (a.k.a. Appendix P): Due to the size and amount of information presented, especially in Appendix S, it is difficult to search and find specific information. Provide additional detail, including page numbers and subheadings, if appropriate, for F&T-related appendices in the Table of Contents. Please note: Appendix S lists an Appendix A and B within it; however, there is no information provided in those appendices. Please ensure that the appendices provided to support the fate and transport report are organized, presented in a manner that facilitates searching for specific information, and in general supports the review process.

SPECIFIC COMMENTS

Executive Summary

23. Page ES 1-1, first paragraph, last sentence. Remove item 4 from this list of activities/evaluations included in the F&T Report. The F&T evaluation and associated modeling should not focus on predictions of the transport and fate of radionuclides once they reach groundwater. A better understanding of the hydrologic conditions of the site should be developed and used to evaluate transport in groundwater under OU-3.

24. Page ES 1-3, last 2 paragraphs. Revise the Executive Summary to reflect the changes made to the document in response to the EPA's comments on the F&T Report.

SECTION 1 Introduction

25. The last sentence in the first paragraph states Section 1.4 identifies where additional information regarding aspects of this study can be found outside this report. Either add this information to Section 1.4 or revise the statement.

26. Ensure all information presented in sections 1.1, 1.2, 1.1.2, 1.1.3, and 1.1.4 is consistent with the RIA. Alternatively, these sections could just reference pertinent sections of the RIA.

1.1.4 Regulatory History

27. Delete the three bulleted items in this section if they are not directly related to the modeling conducted in this study.

1.2 Study Objectives

28. Rather than use "ROD Alternative #1" Cap and "CETCO BENTOMAT® SDN" Cap, revise the text in Section 1.2 to define the Cap 1 Alternative and Cap 2 Alternative. Specifically, describe the physical characteristics and infiltration assumptions for each of the caps considered and refer to them as Cap Alternatives 1 and 2 throughout the document.

1.3 Study Design

29. Delete bullet number 4 on page 1-4. This evaluation will be done as part of OU3. See comment 23 above.

2.1.2 Field Handling

30. Page 2-2. This section discusses samples that were shipped on dry ice (-110 F) to the laboratory. Materials at this site have never been subjected to this temperature extreme. Some literature suggests this can affect the mineral surfaces and exchanges. Discuss in the text of this section how freeze-thaw effects may have impacted mineral surfaces in the samples and any related effects on this study.

2.2 Laboratory Analysis

31. Page 2-3, first bullet on the page. The sequential extraction method derivation is not detailed and no citation is provided in the text. Discuss in the text whether there is any comparative usage from literature and include relevant citations.

3.1 Radiological Results

32. Page 3.1, footnote 6. Indicate in the footnote whether the ANSII reporting standards were used by the labs.

33. Page 3-2, first sentence continued from the previous page. The variability in the Th activity may indicate that the homogenization of the sample(s) in the lab was not complete. Mixing and stirring of the materials as shown in the appendix photos can segregate materials by their density, and extreme

care must be taken to fully subsample this material. It is not clear in the provided photos how many subsamples were obtained or how the subsamples were pulled from the material. Please clarify in the text of this section the number of subsamples collected and provide more definitive information on how they were collected from the sample.

3.2 General Geochemical Parameters

34. This section indicates that, in general, barium concentrations scaled to gamma counts are consistent with the expected association of radionuclides with leached barium sulfate waste. This correlation seems to be overstated and there are some notable exceptions that should also be acknowledged and discussed in the text (e.g., the sample with the highest concentration of barium has the third lowest counts per minute (cpm) and the sample with the second lowest cpm has the fourth highest concentration of barium).

3.4 Mineralogical Analysis

35. Page 3-3. The last sentence in this section states that the data allow a determination to be made that barite (i.e., RIM) has not migrated downward because of the absence of barite detects in non-RIM municipal solid waste (MSW) samples. This appears to be an overstatement given that the non-RIM samples were collected 9 to 23 feet below the RIM samples. Delete this sentence.

3.5 Scanning Electron Microscopy

36. Page 3-3, 1st paragraph in section. This paragraph indicates that encapsulation of RIM within $BaSO_4$ material will limit radionuclide migration; however, it is not clear from the text how much of the submicron phase is actually crystalline barite. Please include an appropriate data set and/or literature references to support this claim, and provide an estimate of what percentage of the material is considered or estimated to be crystalline barite.

3.6 Sequential Extraction Analysis

37. Page 3-4, numbered bullets, 1st bullet. Please include an estimated percentage or amount of barium carbonate versus barium sulfate in the samples.

38. Page 3-4, 3rd bullet. Iron (Fe) is released in every extraction step, indicating it is widespread in multiple sources. It is reactive, and in all solid phases has some sequestration capability for U, Th and Ra. Numerous sorptive phases are implied, and while none are as adsorptive as hydroxide, please indicate in the text whether consideration was given to other phases contributing to the adsorption capacity or whether the adsorptive capacity of hydroxide was overestimated.

39. Page 3-4, 4th bullet. Please state if extractant 1 (for soluble/weakly adsorbed mineral phases) is an oxic solution. If it is, please explain why some of the residual uranium dioxide (UO_2) was not leached, since UO_2 should be soluble with an oxic extractant.

40. Page 3-4, 6th bullet. This bullet includes a statement that ends with, "...which is consistent with the ingrowth of radium from thorium." Expand the discussion regarding the extent to which RA 226 has ingrown from Th 230, given that Ra would have been present in the original ore. (Also see related comment in section 4.1.1.)

41. Page 3-4, last paragraph. This section implies that FE oxides/hydroxides are part of the insoluble chemical forms that U, Ra, and Th are associated with. However, Fe oxides/ hydroxides are generally reactive and not considered "insoluble." This wording is misleading and largely inconsistent with other statements in the text. Revise this paragraph, and elsewhere as appropriate, to remove claims of insolubility for the Fe oxides and hydroxides.

42. Page 3-4, last paragraph. The text states that the results indicate predominately insoluble forms of radionuclides, and the results for radium (12% as provided in Section 3.7) clearly differed from those of uranium and thorium (2%). This discussion should note the valence states of radium versus uranium and thorium. Also please revise this section to discuss the variation in percentages that was demonstrated between these radionuclides. Refer readers to Section 3.7 for additional discussion.

3.7 Sequential Batch Leaching Tests (SBLT)

43. Page 3-5 and page 2670 of Appendix S. Text and tables from a Certificate of Analysis by MCLinc in Appendix S indicate that EPA method 1312 was followed for the SBLT testing. The appendix indicates the second solution used in the SBLT tests was EPA 1312 Extraction Fluid #2, which is designed for use in determining leachability for soils west of the Mississippi River and has a pH of 5.0. However, Method 1312 indicates that for all waste samples, regardless of their locality, an extraction fluid with a pH of 4.2 should be used. The samples collected for conducting the fate and transport evaluation are waste samples. Please explain this discrepancy and revise the text if appropriate to clearly identify and justify this modification to the EPA 1312 method. Discuss how this modification potentially affects the results.

44. Page 3-5, 3rd paragraph. Low pH (5.0) extractant is stated to increase radionuclide leaching because of carbon dissolution. However, diminished adsorption could also be an important consideration. Discuss the issue of diminished adsorption versus carbon dissolution in the text of this section.

45. Page 3-5, 3rd and 4th paragraphs. The text states that radionuclide activities decreased over successive extractions; however, this is inconsistent with the data. Ra-226 increased or remained about the same in 11 of the 22 tests (excluding duplicates) and Th-230 increased or remained the same in 10 of the 22 tests. Revise text in these paragraphs to more accurately reflect the entire data set. This comment also applies to Section 4.1.1, 4-2, Bullet 4a.

3.8 Synthetic Precipitation Leaching Tests (SPLP)

46. Page 3-6. Some of the SPLP leachate values in Table 3-7 do not appear to be realistic (e.g., pH. of 9.33.). Please discuss the range of leachate values measured, whether the values are realistic, and if not, discuss any limitations associated with this data set.

47. Page 3-6. The last sentence on this page implies that uncorrected SPLP data underestimates the ionic strength of pore water; however, higher ionic strength equals less adsorption. Please discuss the implications of this relationship in the text of this section. Include discussion of the effect of pore water residence time on evolved ionic strength and present the math of the derivation and the estimated factors that were used to define this variable.

4.1.1 Radionuclide Leaching

48. Page 4-1and 4-2, bullets 1b and 1c. The statement in 1b indicates that Th is present mostly as Th-oxides or Fe-oxide phases, and bullet 1c states that Ra generally occurs in the same phases as Th. Previous discussion has indicated that most Ra occurs with BaSO4 phases; therefore please explain how Th and Ra can generally occur in the same phases or revise the text in this section to clarify the Th and Ra phases.

49. Page 4-1 and 4-2, bullet 1c. Expand the discussion regarding Ra ingrowth. The last sentence in the bullet states that Ra may have been introduced during the original processing. Please expand and clarify this statement since it is also true that Ra was present in the original ore and processing was designed to remove Ra in a SO4-rich phase.

50. Page 4-3, bullet 5a. Discuss in the text the range of concentrations of radionuclides that could potentially leach according to the SBLT results.

4.2 Fate and Transport Model Calibration

51. Page 4-5, bullet 2. Please discuss whether the two orders of magnitude variation in effective DOC is realistic and whether it is accounted for in the sensitivity analysis.

52. Page 4-5 and 4-6, bullet 4. Please specify the actual net variation of mass based upon the five orders of magnitude variation in the saturation index (SI) results, and whether it is accounted for in the sensitivity analysis.

53. Page 4-5 and 4-6, bullet 4. Please provide an explanation for the assumption that BaCO3-SO4 solution will be less soluble than BaCO3. Please discuss whether the solubility is proportional to the BaCO3 content of the BaCO3-SO4 solid solution series (i.e., more soluble with a higher proportion of BaCO3).

5.1.2 Groundwater Mixing Model

54. Page 5-3, bullets 1-4. Groundwater velocities of 2.5 to 25 feet per year are stated in the bullets, however the values are inconsistent with the velocity cited in the RIA. Section 5.6.2.7 (page 129) of the associated RIA presents an estimated groundwater velocity of 41 to 83 feet per year, more than 3 times that stated in this section. This apparent underestimation of groundwater velocity could significantly affect the model results. The EPA is concerned that the assumptions and parameters used in the groundwater mixing and migration models are not sufficiently understood at this site and were not sufficiently conservative for a screening level evaluation. Additional information on the hydrologic system at the site is necessary to adequately evaluate potential migration of radionuclides in groundwater and should be conducted during the OU3 investigation.

55. Page 5-3, last paragraph on page. Please discuss the maximum estimated and known depth of RIM occurrences site-wide (Area 1 and Area 2) to provide a better understanding of subsurface conditions. The potential scenario of RIM occurring in saturated conditions should be discussed in more detail in this section. Consider average and maximum water elevations recorded on site and discuss RIM locations and concentrations typically at saturated depths, as well as RIM at depths that may be intermittently saturated.

5.2 Model Assumptions

56. Page 5-4. This section discuss assumptions related to microbial reductive dissolution. This effect is well detailed in the literature and DOC does not have to be "high" for it to occur (Matthews et al., 2006; Landa et al., 1991). Please clarify in the text of this section why this assumption was made and include a discussion of the implications to the model outputs.

57. Page 5-4. SBLT solution #1 with a pH of 7 was assumed for the first 100 years; however, some of the measured SBLT pH values were less than 3. Discuss whether a range of pH values was considered in the model or sensitivity analyses and how such a range of pH values might impact the results.

58. Page 5-4, bullet 2. This bullet states that a DO level of 7 mg/L (oxic condition) was assumed for all influent during the SBLTs. This appears to be an unsupported assumption regarding the DO level. Fe-reducing (and perhaps SO4-reducing) conditions are occurring within the subsurface at the landfill, which affects DO levels. The lack of sulfide detections in RIM materials is not considered "proof" of exclusive oxic conditions in the landfill in RIM areas. Please provide in the bullets and/or the associated text the actual site-specific geochemistry or pE values used in the redox sensitivity tests. Discuss the potential implications of an incorrect assumption on DO. Additionally, please clarify how the term "reducing" is used in the last sentence of the second bullet.

5.3.3 Groundwater Mixing Zone Model

59. Page 5-6, and Table 5-5. This section states that a simpler modeling approach using fewer model parameters was used in the groundwater mixing zone model because the primary intent of the F&T evaluations was to evaluate radionuclide leaching and migration in the vadose zone. Also, there is no information provided on the pE of the groundwater, and it is not clear how using a "simpler" modeling approach affected model outcomes. Since the analyses and modeling performed for this F&T evaluation did demonstrate the capability of radionuclides to leach from RIM and did demonstrate that they have a potential to reach the groundwater, the EPA has determined that it is more appropriate to do a robust evaluation of the potential for migration of radionuclides in the groundwater as part of the OU3 investigation using site-specific parameters.

5.4.4 and 5.5.4 Groundwater Radium Activities in Groundwater Mixing Zone

60. Page 5-8 and 5-10, first paragraph in each section. There is insufficient information presented in the F&T documents to support these conclusions. A more in-depth evaluation of contaminant migration potential in groundwater will be conducted as part of OU3.

61. Page 5-9 and 5-10. The last paragraph in each section contains both subjective and misleading language that is not supported by the data set. Delete each of these paragraphs.

5.6 Model Sensitivity

62. Page 5-7, bottom and 5-10, bottom. Sorption to FeOH3 seems relatively small in the assumed oxic vadose zone. This sorption of FeOH3 seems to have been determined solely from the leaching test, but it is not clear if this approach is realistic for the site conditions. Please evaluate whether additional sensitivity evaluations would help clarify whether this is representative of site conditions.

SECTION 6 Conclusions

63. Page 6-1. The second paragraph states that the leaching potential from RIM is low, generally less than 5 percent; however, the conclusions do not discuss the concentrations of radionuclides that leached in the analytical tests. Revise the conclusions to indicate that radionuclides can leach at concentrations above regulatory limits. Also discuss whether migration of RIM through the vadose zone was modeled without an engineered cap to reflect conditions during the 40 years from placement to the present.

64. The models conclude that radium present in the underlying groundwater above MCLs will exhibit limited migration (less than 100 feet) due to attenuation rates. This conclusion is not well supported in the Report and appears inconsistent with the alluvial groundwater geochemistry. The assumptions used for geochemistry of the groundwater parameters in the models are not readily apparent in the document and should be clarified. Missouri River alluvium is largely Fe to SO4 reducing, conditions that favor radium solubility. To date, it has not been demonstrated that the Ra identified in groundwater either is or is not from RIM. This conclusion should be deleted and re-evaluated during the OU3 investigation.

65. Page 6-2. The final conclusion as presented predicts no current RIM impacts to groundwater; however, additional data are needed to make this determination, as the current data set cannot definitively rule out potential RIM impacts to groundwater. Delete this conclusion, and include discussion of the leaching results and vadose zone modeling in the conclusions that indicate leaching of RIM to groundwater is possible.

SECTION 7 References

66. Please remove references that are no longer valid, such as those referring to HYDRUS.

67. Please add Canavan et al., 2006, to the list of references. It is included in model code notes but not in the References.

FIGURES

For any figures that present graphs showing radionuclides, please clarify whether the data represents a total concentration or the concentration of a specific isotope of the element (e.g., Figure 3.5e for thorium or Figures 4-4a for thorium, radium and uranium).

Figure 1-2 Simulation Approach for Radionuclide Fate & Transport using PHREEQC

68. Add 'Not to Scale" on this figure, if appropriate.

Figure 2-1 RIM Sample Locations and Field Gamma Activity

69. Add "cpm to legend".

Table 2-1 Description of RIM and Landfill Samples Used for Fate & Transport Evaluation

70. On the Table 2-1 footnote, clarify that the "Field Count" column units are counts per minute.

Appendix J - HELP Predictions

Appendix J, Section 2.1 Cover Design Specifications, page 2-1. Provide the following information:

- indicate whether there are existing cover soils considered;
- state whether the 2% slope represents the top of the landfill and whether there are side slopes that are steeper;
- state the drainage length;
- describe the closure grading plan (Appendix J, page 2-2, HELP Results Table);
- clarify whether the change in storage of 0.019 was from the HELP model;
- Appendix J - provide additional detail on what climate data were used (what years, which station, peak rain event, etc.);
- Appendix J, Figure 2 - clarify in the text what is causing the low spikes in runoff values (i.e., at 8 years, 40 years, and 75 years);
- explain the significance of the HELP model ET not matching the Thornthwaite and Mather calculations in the Appendix J text;
- Appendix J, Figure 5 - plot the HELP model max/min on this graph;
- Appendix J, Figure 6 - plot 10-4 also to better illustrate that the plateau corresponds to the amount of water that is available to infiltrate;
- Appendix J, page 3-1 - indicate in the bullet list that the GCL liner is 500 mils;
- Appendix J, page 4-1 - indicate whether the 1-ft thick sand layer is the drainage layer.

EPA Partial Set of Comments on the (Draft) Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill Operable Unit 1, Bridgeton, Missouri September 30, 2016

The following comments on the draft *Estimated Three-Dimensional Extent of Radiologically Impacted Material* are provided in support of the agency's review of the September 30, 2016, draft Remedial Investigation Addendum (RIA), in particular the Extent of RIM figures and associated information regarding radiologically impacted material (RIM) location. The agency will continue to review this document, and provide additional comments on the portions of the document relating to the Final Feasibility Study.

GENERAL COMMENTS.

I. This document is used to support the updated extent of RIM figures and associated discussions provided in the Draft RIA; as such, the data (hard and soft) and the interpretations used to develop the updated extent of RIM figures and related discussions must be included in the RI Addendum. Add this information into the RI Addendum where the extent of RIM information is discussed.

II. Provide details on how the soft data sets were interpreted and then normalized to create inputs for the Multiple Indicator Kriging (MIK analysis). These details should include but are not limited to: median shifts, baselining details, discussion of excluded outliers in the soft data set, and other limitations related to the interpretations and normalization process for the soft data set. See related specific comment to Section 3 for more information.

III. Appendix B of the document provides an extensive series of graphs comparing hard and soft data points in both a log scale and a linear scale. Include a more detailed description in the supporting text sections (3.1, 3.2, etc.) of how these graphs were developed (see previous comment). The keys for each of these graphs should be revised to include a note explaining the heavy black line included on the soft data portion of the graphs as it is currently not included on the key.

SPECIFIC COMMENTS

EXECUTIVE SUMMARY

1. Page I, 3rd paragraph. The statements included in this paragraph contradict the stated purpose of the submittal as provided in the 1st paragraph of the Executive Summary. The purpose of this submittal is to provide the basis for the estimated volumes to support the excavation alternatives as correctly stated in the 1st paragraph. A kriging thickness of 6" is specified in the report specifically to provide a practical limitation on excavation lift thickness. Delete this entire paragraph.

2.1 Overview

2. Page 2-1, Last paragraph, 2nd sentence that starts with: "*The MIK method is commonly used....*" Delete the following from the end of this sentence "*...~~and, as such, is well suited to delineating RIM.~~*"

2.2 Relationship Between Radium and Thorium Isotopes, Alpha Radiation and Gamma Emissions

3. Page 2-2. This section discusses the relationship between Thorium and Radium isotopes from soft data (gamma and alpha emissions), and does not consider the larger data set for the project (i.e., hard data). To fully discuss the relationship between Thorium and Radium isotopes found at the site, this section should include a broader discussion and comparison of both the hard and soft data sets. Revise the title of this section to "**Relationship Between Radium and Thorium Isotopes**," and include extra paragraphs to explain what has been documented regarding the relationship between these isotopes based upon the both hard and soft data sets. See additional comments to this section for more information.

4. Page 2-2. 1st paragraph. This paragraph should explain that, based upon the body of analytical data collected and analyzed, the predominate isotopes present at the site are Thorium 230 and Radium 226. Further, this section should discuss the statistical relationships between the data/results for the Thorium and Radium isotopes, including a brief narrative on the (lack of) secular equilibrium between these two daughters of the Uranium 238 decay chain.

5. Page 2-2, 2nd paragraph. The second paragraph briefly mentions that historical leaching has effected secular equilibrium, but fails to clarify that this historic process has resulted in (based upon the body of analytical data) ratios of Thorium 230 and Radium 226 in both Area 1 and Area 2 that are consistent with leached barium sulfate residues (LBSR). Please add this point to this paragraph.

2.3 Threshold Concentration Values

6. Page 2-3, 1st paragraph, 1st sentence. Please revise this sentence to include references to the specific correspondence (by name/date) that assigned the three pre-defined Threshold Concentration Values. Additionally, clarify why the additional Threshold Concentration Value of 500 pCi/g was selected and used in the analysis.

SECTION 3 DATA PROCESSING

7. Page 3-4. Briefly discuss in this section previous efforts to determine/calculate volume estimates and corresponding determinations of the extent of RIM. Also include a discussion of identified limitations of the previous efforts and how this MIK geo-statistical estimating tool compares to the previous estimating efforts conducted at the site. Also include statements regarding how the previous estimates and related data sets have been utilized to better support the estimates currently provided in this document.

3.1 Overview of Data Types

8. Page 3-4, paragraph after numbered bullets. Please check and correct the figures references in the 1st sentence (Figure 2 should be Figure 6, and Figure 3 should be Figure 7).

3.2 Hard Data Processing

9. Page 3-5, paragraph after numbered bullets. Please check and correct the figures referenced in the 1st sentence (Figure 1 should be Figure 6, and Figure 2 should be Figure 7).

3.3 Soft Data Processing

10. Page 3-5. Provide specific details on how the soft data sets were interpreted and then normalized to create inputs for the MIK. These details should include but are not limited to: median shifts, baselining details, discussion of excluded outliers in the soft data sets, and other limitations related to the interruption and normalization process for the soft data set.

3.4 Changes in Land Surface Elevation

11. Page 3-7, last paragraph of section, Table A-1 and Table A-2. Table numbers should be changed to prevent confusion between Radium/Thorium concentrations and estimated volumes that all use similar table numbers.

4.5 Multiple Indicator Kriging

12. Page 4-5 and 4-6, 1st paragraph. Discuss how the results (extent and volumes) are not overestimated if the results for Radium and Thorium are analyzed separately, and then combined when both Ra and Th are determined to be present by MIK. Additionally, discuss if contamination could be overestimated when it is identified/present in areas that are less than the entire chosen block size of 10-meter x 10-meter x 0.015 meter.

5.2.2 Set Interpolated Values to Zero beyond Practical Extents and Other Surfaces

13. Page 5-2, 1st paragraph. The MIK assumptions of both an elevation bottom below the level of the material deposited and a no defined bottom "limitation" could provide a prediction of RIM beneath the landfill waste. Briefly discuss this concept and any related findings in the text of this section.

6.2 Assumptions

14. Page 6-2, Bullets, 4th bullet (top of the page). Based on the sample numbers, clarify which of the 4 scenarios are validated.

15. Page 6-2, Bullets, 5th bullet. Revise this bullet to delete the word *"are"* and to state, *"Gamma Emissions can be a reliable relative indicator..."*

16. Page 6-2, Last bullet. Discuss how accuracy would be effected by selecting the 0.25 or the 0.75 selection criteria, and explain why these were not chosen.

6.3 Limitations

17. Page 6-2, 2nd bullet of section. Discuss in this section, if finer block Kriging values (smaller than 10-meter x 10-meter x 0.15 meter) were performed the estimated volumes could decrease but could not increase.

7.2.1 Initial "Best-Estimate" Extent and Volume Calculations

18. Page 7-1, 2nd bullet at bottom of the page. Revise this bullet discussing soft data to correctly refer readers to Section 3.3.

19. Page 7-1, 3rd bullet at bottom of the page. Revise this bullet discussing variograms to correctly refer readers to Section 4.2.

SECTION 8 DISCUSSION

20. Page 8-1, 1st paragraph. Explain further the 3D CAD and GIS files mentioned in this paragraph, and consider including this information as a new appendix to this report or to the RIA.

21. Page 8-1 and 8-2, 5th bullet. This bullet is interpreted to mean that since the block sizes are 10m x 10m x 0.15m, any exceedance in that volume would flag the entire volume to be removed even when a smaller volume could be removed based on the scenarios. Clarify this item and revise the bullet appropriately. Also, see related comment provided for Section 4.5.

22. Page 8-2, Bullets, 6th bullet. This bullet discusses the potential limitations of the model and how the volume estimate may not include all potential RIM located above the predicted RIM containing cells. The bullet indicates that the RIM volume estimates could be underestimated due to this limitation. This premise seems reasonable, in particular with the assumed cell thickness/lift depths of 6 inches (0.015m); however, it would appear that with the cell/block size of 10m x 10m, the fully estimated volumes could still be an overestimate. Discuss this item, and revise the bullet appropriately. Also, see related comment provided for Section 4.5.

EPA Comments on the (DRAFT) Updated Baseline Risk Assessment
Appendix Q to the Remedial Investigation Addendum
West Lake Landfill Operable Unit 1, Bridgeton, Missouri
October 2016

GENERAL COMMENTS

I. Erroneous consideration of existing OU-1 restrictive covenants and land-use restrictions. This draft of the baseline risk assessment (BRA) includes descriptions of the restrictive covenants and associated land-use restrictions in several sections. In addition to these descriptions, the restrictive covenants are used as justification to eliminate or adjust certain exposure scenarios for which exposure pathways would otherwise be complete. The EPA previously provided comments on this issue during our review of the original BRA in a letter dated June 4, 1999. Respondents' responses to the EPA's comments were provided in a letter dated July 26, 1999 from Paul Rosasco on behalf of the OU-1 respondents. The EPA has included our original comment and the response below:

EPA's June 1999 Comment
While it is appropriate to design future hypothetical receptor scenarios based on reasonably anticipated land-use, it is not appropriate to preclude evaluation of pathways based on the existence of deed restrictions, restrictive covenants, or other institutional controls. These existing institutional controls, in effect, are remedies, and the pathways they are intended to preclude should be evaluated in order to properly incorporate such restrictions into the remedial strategy as appropriate.

Respondents' July 1999 Response:
EPA in its comments dated June 4, 1999 has also provided two additional general comments regarding the BRA. First, EPA has indicated that it is inappropriate to preclude evaluations of potential hypothetical future receptor scenarios based on the existence of deed restrictions, restrictive covenants or other institutional controls. The BRA will be revised to include a hypothetical scenario involving a commercial/industrial worker working in a building located adjacent to Areas 1 and 2 but also capable of conducting ancillary activities such as outdoor storage or parking lots within Areas 1 and 2. The text will include an acknowledgement that deed restrictions exist that prohibit certain activities from occurring in Areas 1 and 2.

The EPA's position on the role of restrictive covenants in Baseline Risk Assessments has not changed from what was stated in our 1999 comment to the original BRA. Therefore, statements in this draft BRA that conclude exposure scenarios are not evaluated because of current restrictive covenants should be removed. The EPA agrees that the probability of future residential land use on OU-1 is highly unlikely, and therefore, it is reasonable to not carry the residential scenario through a full evaluation in the BRA. However, it is reasonable to assume there is a potential for a storage yard on top of the landfill. Therefore, please adjust the future storage yard worker scenario so that it is located on OU-1, consistent with the previous BRA.

II. RAGS Part D tables. The EPA Region 7 requires the use of the Risk Assessment Guidance for Superfund (RAGS) Part D tables (EPA, 2001). Standardization of the tables was determined to be necessary to achieve Superfund program-wide reporting consistency. The planning tables were developed to clearly and consistently document important parameters, data, calculations, and conclusions for all stages of human health risk assessment development. The Planning Table formats should not be altered (i.e., columns should not be added, deleted, or changed); however, rows and footnotes may be added as appropriate.

Please populate new tables according to the format prescribed in the RAGS Part D, and add them as an appendix to the BRA. Blank tables and worksheets which can function as templates are available for download at the website listed below:

U.S. EPA. 2001. Risk Assessment Guidance for Superfund: Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments. Publication 9285.7-47. Office of Emergency and Remedial Response, Washington, D.C. https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-d

III. Incorporate all available soils data and exposure point concentration calculations (EPCs). The EPA recognizes that several sets of more recent soil sampling data were not available in time to incorporate into this first draft of the BRA. Consistent with comments provided in our previous letter on the body of the Remedial Investigation Addendum (RIA), please incorporate and consider all available soils data collected from OU-1 (Area 1, Area 2, and the Buffer Zone/Crossroads Property). This should include all the soil samples collected as part of the Surface Fire Prevention Removal action, the EPA split samples collected during the Additional Characterization of Area 1 and Area 2, the samples collected for the radon emanation portion of the EPA Pyrolysis Study, the samples collected by Cotter N.S.L. during and after the Additional Characterization of Area 1 and Area 2, and the EPA's additional analysis by Southwest Research Institute (SwRI) of a sub-set of the Cotter data.

This data should be evaluated according to the data usability process described in Section 2 of the draft BRA, and consistent with the comments in this letter related to those sections. The EPA would like to point out that our re-analysis of certain Cotter samples by SwRI did not confirm the levels of Thorium-230 reported by Test America. In addition, several of those samples were collected from borings for which additional sampling data exists from the same or very near depth intervals analyzed by Eberline Laboratory as part of the Phase I and Additional Characterization investigations, and by SwRI as part of the radon emanation portion of the Pyrolysis Study. These other data sets also do not confirm the levels of Thorium-230 reported by Test America for certain Cotter samples.

Because the addition of the data described above has the potential to significantly change the EPCs, recalculation is warranted. Also, with regard to the EPC calculations, the EPA does not agree with the statements made in the BRA that ProUCL is not a suitable tool. However, the EPA does recognize that some of the data sets utilized to calculate certain EPCs are not represented by parametric statistics, may have a high level of variability and skewness, and are not representative of commonly used probability distributions, such as a normal distribution. As a result, careful consideration should be given to the ProUCL guidance, in combination with a knowledge of statistics and of the Site investigations, in order to choose representative and conservative EPCs. The EPA has provided additional direction later in this letter on the calculation of EPCs, including the use of non-detects, duplicates, and samples reported as less than the minimum detectable activity (<MDA). The EPA has also attached to this enclosure an April 20, 2017, memorandum titled, "Computing 95% Upper Confidence Limits of Means of Radionuclides of Concern, West Lake Landfill Site, Bridgeton, MO," which describe an approach to utilize the information provided by ProUCL to pick appropriate radionuclide UCL

values at the Westlake Landfill Site. Because the EPCs described in the attached April 20, 2017, memorandum were generated from a data set that does not include all of the site sampling data, the summary and suggestions should be utilized as guidance only for future EPC calculations. Please include, as an attachment to this document, the data sets utilized to calculate the EPCs and the associated output from ProUCL.

IV. Updates to the EPA's Preliminary Remediation Goals for Radionuclides (PRG) calculator. Significant updates to the PRG calculator were made in December 2016 and January 2017. These updates include changes to the way risks from radionuclides with radioactive progeny can be accounted for. Slope factors associated with 100 years of ingrowth and designated with "+D" have been removed. In addition, new inhalation risk and dose coefficients have been added for Radon-222 and its decay daughters, as well as Radon-220 and its decay daughter. Of particular significance with this update is that age-specific effective dose coefficients for inhalation of Radon-220, Radon-222, and their dosimetrically dominant short-lived progeny have been calculated. Each of these dose coefficients consider the intake of the individual radionuclide (the "parent") without contribution from any progeny, but include contribution from progeny produced in the body after intake of the parent.

The EPA recognizes that these updates were completed after the submission of this first draft of the BRA. However, given the nature of the agency's comments above related to including additional data, recalculating EPCs, and required changes to certain exposure scenarios, recalculation of the PRGs from the updated calculator is warranted. The updated PRGs will reduce the uncertainty associated with the estimated risks for radon, and clarify the contribution risk from daughter products for certain radionuclides. To improve the transparency of the document, add the PRG and RSL calculator's input and output for each exposure scenario and for each pathway that has been evaluated separately.

V. Appropriate Time Frame to Consider Risks in the Future. Due to the fact that Thorium-230 is present at the site in concentrations greater than its decay products (e.g. Radium-226), radium concentrations will increase over time due to radioactive decay and ingrowth as is stated in the BRA document. Because the half-life of Thorium-230 is approximately 75,400 years, the maximum Radium-226 won't occur during the 1000-year study period. Expand the discussion in Section 3 of the BRA related to this issue. Include in this discussion the time it will take for Radium-226 to reach its maximum concentration. In addition, using the same methodology utilized to calculate the future EPCs considering decay and ingrowth for the 1,000-year study period, calculate EPCs for Thorium-230 and Radium-226 for Area 1, Area 2, and the Buffer Zone/Crossroads property at the previously determined time frame. As stated on page 49 in footnote 11, a 1,000-year study period was selected as relevant and appropriate based on design requirements set forth in 10 CFR Part 61 and 40 CFR Part 192. The EPA agrees that the standard specified in 40 CFR 192.02 (a), specifically that controls for residual radioactive materials should be designed to be effective for up to one thousand years, is potentially an ARAR for the selection of a remedy for OU-1. Include in this expanded discussion more details surrounding the selection of the 1,000-year study period, and qualitatively discuss approximately when, during this 1,000-year study period, the maximum risks will occur.

VI. Consideration of the Vapor Intrusion (VI) exposure pathway. Not considered in this document is whether the Vapor Intrusion pathway is complete for any potential receptors. Include discussion wherever appropriate in this BRA, considering the likelihood that OU-1 COPCs have pathways for exposure that could be complete as a result of VI. The focus of this discussion should be related to possible radon migration, but consideration should be given to any VOC COPCs. Refer to the OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (OSWER Guidance 9200.2-154, https://www.epa.gov/sites/production/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf) for how to approach this evaluation.

VII. The terms "CERCLA risk" and "CERCLA risks" are used throughout the document including the Executive Summary. Change this term to "human health risk" or simply "health risk," as appropriate. Check and resolve globally.

VIII. Provide a data usability assessment as described in the EPA guidance (e.g., Guidance for Data Usability in Risk Assessment (Part A)); https://rais.ornl.gov/documents/USERISKA.pdf). Specifically, there needs to be sufficient justification for using and excluding data from the risk assessment.

IX. Revise the tables in this document by adding commas where appropriate to numbers that contain more than three digits, e.g. 1,000 and 10,000.

X. Page 7. Make revisions throughout the BRA to ensure consistency with the RIA, as revised to address the EPA Region 7's comment letter dated March 14, 2017. This should include, but is not limited to, discussions of historical on-site operations, the various areas that make up OU-1 of the Site, and Figure 1.

SPECIFIC COMMENTS

TITLE PAGE

1. Revise title page to include "Appendix Q" before the title.

TABLE OF CONTENTS

2. Page vi, Table of Contents. Revise the Table of Contents to include all attachments.

LIST OF ACRONYMS

3. Page viii, Acronym list. Please add unit risk factors (URFs) to acronym list (1st used in Section 4.1.2 on page 71).

EXECUTIVE SUMMARY

4. Revise the Executive Summary as necessary after responding to the comments in this letter.

1 INTRODUCTION

1.1 Overview

5. Page 7, Paragraph 2. Include a reference in this paragraph to the section of the RIA that provides details for what portions of the Site make up the "unregulated landfill," and what portions of the Site make up the "regulated landfill."

6. Page 7: Expand the discussion in paragraph 3 to more clearly define the terms "on-site," "on-property," and "off-property" as they relate to evaluating risks for the exposure scenarios. Add to

this paragraph a definition for "landfill receptors." This expanded discussion should remain consistent with Section 3.1 where these terms are defined in more detail.

1.1.1 Objectives of the Baseline Risk Assessment

7. Page 8. Add a sentence at the end of this section that indicates exposure pathways related to groundwater are not being addressed in this risk assessment, and will be evaluated as appropriate as part of the remedial investigation work for OU-3 of the Site.

1.2 BACKGROUND

8. Page 8. Correct the reference to the Remedial Investigation Addendum Report so that it is clear this reference is not being made to the original Remedial Investigation Report (EMSI 2000).

1.2.3 Summary of Landfill Contamination

9. Page 9, First Paragraph. Delete the sentence that starts, "The EPA previously determined that..." as the definition of RIM is not utilized in this document to evaluate risks.

10. Page 9, Second Paragraph. Add references to the figures in the RIA which identify the areal extent of RIM, the non-combustible cover, and which show cross-sections that depict the depths of RIM.

1.2.3.1 Area 1

11. Page 10, First Paragraph. Provide a reference to an existing map, or add a figure that depicts Area 1 along with the extent of the non-combustible cover, the underground diesel tank, the septic tank associated with the nearby landfill office building, and the gate near the septic tank. In addition, clarify that the non-combustible cover has been placed on top of the abandoned asphalt parking area.

1.2.3.2 Area 2

12. Page 10, Third Paragraph. Provide a reference to an existing map, or add a figure that depicts Area 2, the Buffer Zone, and the Crossroads property along with the extent of the non-combustible cover and the rock buttress.

1.2.3.3 Buffer Zone and Crossroad Lot 2A2

13. Page 11, Second Paragraph. Clarify in this section the various sampling events, including both surface and subsurface sampling. Provide a date for when the surface soils to the west of Area 2 were sampled. The last sentence in this paragraph states, "...the contamination is generally considered to be located at the top of the ground surface." As appropriate, add a reference to sections of the RIA that discuss this area in more detail rather than use the words "generally considered."

2. IDENTIFICATION OF CONSTITUENTS OF POTENTIAL CONCERN

2.1 Data Sources for Constituent Concentrations

14. Page 16, first paragraph. Update the list of data sources to incorporate all available soils data. List all investigations during which soil or radon flux samples were collected since the original RI. Provide a reference to the sections in the RIA where each of these investigations is discussed.

15. Page 16, second bullet. It is the EPA Region 7's practice to consider duplicate samples, along with the original sample, in a baseline risk assessment, and conservatively utilize whichever value is greater. All of the available EPA split samples should be treated as duplicates. Follow this methodology before any EPCs are recalculated, and then edit this bullet to reflect this change.

16. Page 16, fourth bullet. This bullet states that samples denoted with a blank, null, or "<MDA" result were assigned a value equal to one half of the minimum detectable activity (MDA). Because the true result cannot be known if the amount of that analyte is below the detection limit, conservatively choosing to use the detection limit as the result allows for the calculation of EPCs that represent a reasonable maximum exposure. Follow this methodology before any EPCs are recalculated, and then edit this bullet to reflect this change.

17. Page 16, fifth bullet. This bullet describes that negative results were replaced by 0 when calculating population statistics. Incorporate non-detect results whether negative or positive into ProUCL without editing, and utilize according to the guidance for ProUCL.

18. Page 16. The sixth bullet indicates that certain sample results were not considered in this document because the laboratory report could not be found. Clarify whether these results were considered in the original BRA. In addition, provide a reference to the report containing these sample results. As these samples were collected as part of the original remedial investigation for OU-1, include and consider these results in the BRA if the original report presents the results as validated and there is no reason to suspect an issue with the data quality.

19. Page 17. The seventh bullet discusses a set of 23 samples that were still undergoing evaluation. Revise or delete this bullet, as appropriate, after responding to the overarching comment to incorporate all available soils data.

20. Page 17, eighth bullet. Add a reference in this bullet to the more detailed discussion in section 2.5.4 of this document.

2.2 REVIEW OF CHARACTERIZATION DATA

21. Page 17, second, third, and fourth paragraphs. Discuss anomalous data evaluations that were done to determine whether data should be modified or excluded from consideration in this document. Expand this section to include more of the details of the plotting and statistical tests employed for these evaluations. Summarize any findings, and specify the results that were modified or eliminated. If the plots and statistical outlier tests are numerous, add this information as an attachment. Because some but not all samples were collected at depths within each boring that correspond to the highest gamma readings, provide justification beyond the fact that a sample result is higher than most of the other results before modifying or excluding any anomalous data.

2.3 SUMMARY STATISTICS FOR REPRESENTATIVE DATA

22. Page 17. The fifth paragraph and footnote "a" states that any borings that are determined to be outside of the waste disposal boundaries for Area 1 and Area 2, except for those collected from Buffer Zone/Crossroads property, would not be representative of any of the exposure units considered in this BRA. Provide a list of the borings that were determined to be outside the boundaries of OU-1. Provide a summary of the information utilized to make these

determinations, and reference the RIA, as appropriate, to provide readers of this document with additional details. Clarify whether any of the samples from these borings meet the definition of RIM or contain COPCs for OU-1 above the corresponding screening level.

2.4 SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN

23. Page 17, last two paragraphs. Please clarify in this section that all of sequential screening tests performed on the data are described in the next few sections.

2.4.1 Frequency of Detection Screening Test

24. Page 18, second paragraph. Twenty-seven analytes were screened out because their frequency of detection was less than 5%. Unless justification can be provided for why a contaminant is not Site related, evaluate all contaminants that are present above screening levels, and quantitatively carry them through the risk assessment. Revise the section and other affected sections, tables, and figures appropriately.

2.4.1.1 Determination of Detection Frequency for Radiological Constituents

25. Page 18, third paragraph. Add references to the section in the RIA which discusses the investigations and results of samples analyzed by gamma spectrometry using a nuclear spectral library. In addition, clarify that the "RC" series borings were placed in the Buffer Zone/Crossroads property, and represent the second of two investigations where samples were collected from this area as part of the original RI.

2.4.2 Background Screening

26. Page 19, second paragraph. Provide a justification for why the radioactive analytes should be "screened out" if the maximum concentration did not exceed the doubled average background value. The EPA recommends that any contaminants that exceed risk-based screening levels be evaluated quantitatively in the risk assessment. Also, the table with the background screening section is Table 4, not Table 5, as presented in the text. Correct the table reference.

2.4.3 Essential Nutrient Screening

27. Page 19, second paragraph. This paragraph references Region 8 screening levels that results are compared to. Revise this paragraph to state that, when available, screening levels were utilized from the regional screening level tables. Include the date that these tables were last revised.

2.4.4 Toxicity Screening

28. Page 20. The fourth paragraph states that since soil is the source medium, screening values for ingestion and dermal pathways only were considered. Delete this sentence, as Table 5 presents ingestion, dermal, and inhalation screening values, and because soil being a source for contamination does not preclude consideration of the ingestion pathway.

2.5.1 Uranium-235

29. Page 21, second paragraph. In addition to the activity concentrations, add the mass concentrations (i.e., U238 at 99.3%, U235 at 0.7% and U234 at <0.01%) to the discussion about the natural abundance of uranium isotopes. Provide a short explanation for why the two values are different.

30. Page 21. Include discussion on the impact that processing ore had on the ratio of natural uranium.

31. Page 21. The third paragraph states that Uranium-235 concentrations are commonly overestimated when samples are assayed for uranium isotopes by alpha spectroscopy. Provide a reference for this statement, and summarize the cause of this overestimation. The EPA notes that U-235 is often overestimated when Ra-226 is present at elevated levels, and the sample is analyzed by gamma spectroscopy due to the close proximity of gamma energies produced by these radionuclides (185.7 keV for U-235 and 186.2 keV for Ra-226).

2.5.3 Chromium

32. Page 22. The nomenclature used in this section for the chromium valence states is not consistent with later discussions (Section 4.2.9) and tables. Please revise the text to use consistent terminology; Cr^{3+} versus Cr^{III}.

2.5.4 Sample WL-208-U

33. Page 22, paragraph three. Clarify in this paragraph whether any radiological analytical data exists for this sample. If it does not, discuss whether any gamma detections were measured at this boring location, and if so, at what depths. Finally, summarize all analytical data available for this boring at this depth.

2.6 OU-1 COPC Summary Statistics

34. Page 22, fifth and sixth paragraph. Include tables that represent data sets used to calculate each category of EPC (e.g. Area 1 surface soils, Area 1 all soils, etc.), and place them in an attachment to this document along with all the ProUCL outputs used to calculate 95% UCLs.

35. Page 22, fourth paragraph. Add a statement to this paragraph that clarifies why samples were placed into two overlapping groups based on sampling depths, and why a sub-surface only group was not considered.

36. Page 22, footnote 7. As discussed in previous comments, the EPA does not agree with this characterization of ProUCL. Revise this footnote as appropriate after EPCs are recalculated according to the methodology described in the general comment.

Table 1 Summary Statistics for Concentrations of Radionuclides in Samples Collected from OU1

37. Correct the error associated with the listed value for the number of Potassium-40 analyses, (i.e., 271/129).

Table 5 Summary of Screening of Non-Radiological Constituents

38. Pages 28 and 29, Table 5. Compare all the contaminants to the "Target Screening Value." Any contaminants with maximum concentrations that exceed this screening value must be carried through the risk assessment and evaluated quantitatively.

Table 7 Summary Statistics for COPC's in Area 1 - Surface Soil

39. Table 7 through Table 12 provides footnote "a" which indicates that if two or more samples were analyzed, ProUCL was used to calculate a 95%UCL. The footnote further states that if "one or two samples…. [are available]," the maximum concentration is used. Revise this footnote to

clarify what is done for data sets containing two results. The ProUCL User's guide recommends 8-10 samples to estimate a 95%UCL. If the recommended number of samples is not available, utilize the maximum results as an EPC. Revise this footnote, as necessary, after EPCs are recalculated in accordance with previous comments.

3. HUMAN EXPOSURE ASSESSMENT

3.1 CONCEPTUAL SITE MODEL FOR OU-1

40. Page 38, third bullet. Add references to the sections in the RIA that discuss storm water flow and sediment sampling.

3.1.1 Sources

41. Page 38, last paragraph. Include a discussion in this section that explains the relationship between surface and sub-surface soils as contaminant sources for current and future risk evaluations. This discussion should include a brief explanation as to what results are being considered for both time frames and why.

3.1.2.1 Resuspension of Dust

42. Page 39, second paragraph. Add to this paragraph a summary of the findings from the referenced McLaren/Hart investigation that support the conclusion that dust resuspension was not an active release mechanism. Include a reference to the sections in the RIA that discuss the more recent air monitoring for radiological particulates, and summarize the findings in a manner consistent with the historical investigation.

3.1.2.2 Volatilization of Organics

43. Page 39. Paragraph 5 qualitatively discusses the likelihood that the release of volatile organic chemicals (VOCs) would result in a completed pathway for exposure. The EPA notes that the original BRA did not identify any VOCs as COPCs; however, the current draft BRA identifies 1,2-Dichlorobenzene and Chlorobenzene as COPCs. Expand this qualitative discussion to include more consideration of potential future impacts if surface conditions should change. Include in this discussion a summary of the depths that these VOCs were encountered.

3.1.2.4 Leaching from Soil to Groundwater

44. Page 40, second and third paragraph. Revise this section to be consistent with comments provided in the EPA's letter dated March 14, 2017, related to groundwater and OU-3. This section should state that release mechanisms and exposure pathways related to groundwater will be further investigated as part of the remedial investigation work for OU-3.

3.1.2.5 Soil Erosion by Surface Water

45. Page 40. The fourth paragraph states, "This release mechanism was considered in the previous BRA because the eastern edge of the Buffer Zone contained above-background concentrations of radionuclides in surface soil." In fact, page 1.3-14 of the original West Lake BRA states in section A.3.2.2.5 *Soil Erosion by Surface Water*, "This release mechanism was included in this risk assessment because RI/FS sampling indicates that ditches on the West Lake Landfill may contain some elevated concentrations of COPCs." Expand the discussion in this section of the updated BRA by referencing sections of the RIA where storm water sampling and sediment sampling are described. Include in this discussion any conclusions reached about storm water as

a potential contaminant migration pathway. While the paragraph indicates that the release mechanism is not quantitatively addressed in this assessment, include in this section the details of the qualitative assessment.

3.1.3 Potential Exposure Media and Routes

46. Page 41, last paragraph. Refer to comments provided in this letter to section 3.1.2.4, and revise this section accordingly. In addition, the reasons listed in this paragraph used to eliminate the groundwater exposure pathway are insufficient to rule out the consideration of all potential future exposures.

3.1.4 Potential Receptors

47. Page 42. The first paragraph states, "Possible exposure routes for OU-1 media are:..., inhalation of radon..." Revise this item in order to clarify that the inhalation of radon daughter products are being considered as well.

48. Page 42, third paragraph. Define or clarify the use of the term "target receptor," and clarify that the intent of the process was to select which receptors should be evaluated quantitatively.

3.1.5.1 Current On-Property Scenarios

49. Pages 43 and 44. Add to this section a qualitative discussion of workers that maintain or otherwise interact with on-property utilities, such as the septic tank installed just south of the landfill office building.

50. Page 43. The first paragraph discusses the restrictive covenants in place for the OU-1 areas. Add to this list a summary of the land use restrictions required by these restrictive covenants. Also, clarify whether these same land use restrictions apply to the Buffer Zone.

51. Page 44. The first paragraph states, "These remediation workers' exposures at OU-1 are currently controlled and monitored as specified in Health and Safety and Radiation Safety Plans..." Clarify whether these plans address potential exposures to both radiological and non-radiological COPCs.

52. Page 44. Paragraph 2 states, "However, these receptors may be exposed to inhalation of radon, direct radiation from submersion in air..." Add to this list "and daughter products" after "inhalation of radon." Also add a statement that clarifies which radionuclides are causing direct gamma exposure to current receptors, i.e. only radon and its daughter products.

3.1.5.1.1 Current Grounds Keeper Scenario

53. General comment. Indicate in this section which exposure points were evaluated for this scenario, and reference Figure 5.

54. Page 44. The third paragraph states, "The exposure routes for this receptor are direct radiation exposure from contaminated soil and direct radiation from submersion in air." Revise this statement to include inhalation of radon and its decay products.

55. Page 44, third, fourth, and fifth paragraphs. Add to this section a summary and reference to an invoice or other documentation, if available, that demonstrates the number of maintenance events currently conducted on-property over the course of a year, the size of maintenance crews, and the

number of days or hours required to complete a maintenance event. Expand the discussion in this section to include a justification for why these parameters represent a reasonable maximum exposure for this receptor.

56. Page 44. The fourth paragraph presents a method to determine the time of direct gamma exposure for a grounds keeper working in proximity to Area 1 and Area 2 based on the fraction of land that must be maintained in that same proximity out of the total 130 acres. The exposure time computed from this methodology does not appear to represent a reasonable maximum exposure for this receptor. As an example, the third paragraph on page 44 states that an acre conservatively requires an hour of maintenance time. As presented in paragraph 4, the total acreage consisting of a 2-meter ring around Area 1 and Area 2 would be 0.4601 and 0.5985 respectively. A more conservative estimate of the grounds keeper exposure would be to assume that only one grounds keeper does all the maintenance around Area 1 and Area 2 at each maintenance event for the entire year. Using the one hour per acre estimate stated above, that grounds keeper would spend a total of 28 minutes exposed to Area 1 and 36 minutes exposed to Area 2, per event. Using the assumptions laid out in this section, those times equate to about 7 minutes per day for Area 1, and about 9 minutes per day for Area 2. Given that the response to the previous comment may result in changes to the methodology presented in this section, revise the fourth paragraph, as appropriate, to demonstrate the reasonable maximum exposure on-property grounds keeper scenario.

3.1.5.1.2 Commercial Building User Scenario

57. General comment. Indicate in this section which exposure points were evaluated for this scenario, and reference Figure 5.

58. Page 45, second paragraph. The first sentence in this section states the commercial building user is expected to be exposed for 250 days per year for 25 years. After reviewing PRG inputs for this receptor provided in spreadsheets to the EPA on November 21, 2016, it appears that the EPA Rad PRG calculator was utilized to determine the risk for this receptor in three components. These three components included an indoor worker exposed to radon and certain daughter products, an outdoor worker exposed to radon and certain daughter products, and direct gamma exposure to an outdoor worker from the radiological COPCs in Area 1 and Area 2. The PRG inputs reported for the two outdoor worker components of this risk show an exposure frequency of 225 days per year while the PRG inputs reported for the one indoor worker component show an exposure frequency of 250 days per year. Recalculate the two outdoor worker components of risk for this receptor using 250 days per year.

59. Page 45, second paragraph. Revise this paragraph to indicate, for each of the exposure routes being considered, whether the receptor is being exposed indoors, outdoors, or both. Revise the description of the exposure routes to be consistent with section 3.1.5.1 and 3.1.5.1.1 whenever possible.

60. Page 45, third paragraph. The EPA does not agree that the fractions of time per day of direct radiation exposure for an on-property grounds keeper in proximity to Area 1 and Area 2 are applicable to a commercial building user. Revise the exposures times for the current commercial building worker after consulting with the actual commercial building users of the property. Expand the discussion in the paragraph to include a justification for how the revised exposure times represent a reasonable maximum for this receptor.

3.1.5.1.3 Current Off-Property Scenarios

61. Page 45, fourth paragraph. Clarify the meaning of the statement, "All of the surrounding home sites are residences," and how this relates to the selection of current plausible off-property receptors. Provide additional justification to support the statement, "As presented above, relative to residents and commercial building users, the exposure potential for recreational/intermittent users and grounds keepers is low." In addition, replace the term "less exposed receptors" in the last sentence of this paragraph with the specific receptors this term is meant to represent, and provide information that demonstrates these receptors have less exposure.

62. Page 45, fifth paragraph. Expand the discussion in this paragraph to include the finding from the EPA's off-site air monitoring and from the still ongoing on-site air monitoring as they relate to potential exposure to airborne soil particulates. Provide a reference to the section in the RIA that discusses the non-combustible cover, as well as, the two air monitoring investigations.

63. Page 45, sixth paragraph. Reference Figure 5 after defining the exposure points that were evaluated for this receptor.

3.1.5.2 Future Landfill Scenarios

64. Page 46, second paragraph. The last two sentences appear to conflict with each other. The commercial building user's exposure potential is described as relatively low compared to the grounds keeper and outdoor storage yard worker. However, the last sentence indicates that the commercial building user and outdoor storage yard worker were selected for quantitative risk evaluation. Additionally, Table 13 on page 54 and Table 15 on page 57 indicate that an outdoor storage yard worker and grounds keeper are being qualitatively evaluated at landfill receptor locations. As stated in section 3.1.4.3 of the current BRA, "The occupational receptor scenarios...display unique behaviors while working and each will be quantitatively evaluated if complete exposure pathways exist for those workers." Correct the error in the last sentence of this paragraph. Include a justification for why a future commercial building user scenario for a landfill receptor is not being quantitatively evaluated.

65. Page 46. The second paragraph describes the COPC exposure potential for the future construction worker scenario as low relative to the grounds keeper and outdoor storage yard worker scenarios. Provide a justification as to why a future construction worker scenario is not being quantitatively evaluated as a receptor.

3.1.5.2.1 Future Grounds Keeper Scenario

66. Page 46, paragraph 3. Indicate which two exposure points depicted in Figure 5 were evaluated for the future grounds keeper scenario.

67. Page 46, paragraph 4. Similar to the comments provided in section 3.1.5.1.1 for the current grounds keeper scenario, include a justification in this paragraph for why the assumptions of three maintenance events per year, four-person maintenance crews, and one hour per acre represent a reasonable maximum exposure.

3.1.5.2.2 Future Outdoor Storage Worker

68. Page 47, first paragraph. Indicate which two exposure points depicted in Figure 5 were evaluated for the future outdoor storage yard worker scenario.

69. Page 47, second paragraph. The EPA does not agree that the fractions of time per day of direct radiation exposure for an on-property grounds keeper in proximity to Area 1 and Area 2 are applicable to a future outdoor storage yard worker. Revise these exposure times and provide a justification that the revised exposure times represent a reasonable maximum exposure.

3.1.5.3 Future Off-Property Scenarios

70. Page 47, third paragraph. The last two sentences indicate that a future off-property commercial building user's potential exposure will exceed the other occupational scenarios described in section 3.1.4.3. However, section 3.1.4.3 states, "The occupational receptor scenarios...display unique behaviors while working and each will be quantitatively evaluated if complete exposure pathways exist for those workers." Add a justification in this paragraph that supports the conclusion that the other occupational scenarios' exposures will be less than the commercial building user.

71. Page 47, third, fourth, and fifth paragraphs. The future off-property farmer scenario is not evaluated for consumption of contaminated crops or meat/milk. The EPA recognizes that current air monitoring data does not indicate contaminants are migrating off-site. While the plants and animals on the future off-property farm are not being grown or raised in OU-1 contaminated soils, there is a potential that in the future without remedial action off-property soils could become contaminated due to accumulation of windblown particulates from OU-1. Add a qualitative discussion to this section that demonstrates this exposure pathway would not result in additional significant health risks to this receptor.

3.2.1 Evaluation of Series Radionuclides

72. Page 48, fourth paragraph. Update this paragraph to reflect the December 2016 changes to the EPA Rad PRG calculator. Summary information related to this update can be found in the "What's New" section of the website (https://epa-prgs.ornl.gov/radionuclides/whatsnew.html). More detailed information related to the changes can be found in the PRG User's Guide section of the website within Section 2.2 PRG Output Options (https://epa-prgs.ornl.gov/radionuclides/prg_guide.html).

73. Page 48. The last paragraph states that Table 17 contains the same information for material that has aged 100 years or longer. Revise this statement and the corresponding table to be consistent with the assumptions in the updated PRG calculator.

3.2.3 Current Exposure Point Concentrations in Soil

74. Page 49. The fourth paragraph states that soil exposure point concentrations comprise the source term for determining exposure point concentrations for radon and daughter concentration. Revise this statement to include the specific soil exposure point concentrations being referenced. In addition, add a statement that describes the data being utilized to determine exposure point concentrations for radon and daughter products, i.e. radon flux measurements collected in 2016.

75. Page 49. The fourth paragraph states that the non-combustible cover precludes direct exposure to soil at OU-1. However, the non-combustible cover was only placed in areas where RIM was determined to be at the surface. The cover does not extend over the entire surface of Area 1 or Area 2. Additionally, no specific information is given about the surface conditions of the buffer zone/crossroads property. Therefore, the non-combustible cover does not preclude direct exposure to all the soil at OU-1. Expand the discussion in this section to include details of the

surface conditions of all of OU-1 as they relate to potential exposure to OU-1 soils. Clarify whether pathways may be complete in OU-1 or the non-radiological COPCs, and whether those risks should be evaluated.

3.2.4 Future Exposure Point Concentrations in Soil

76. Page 50, second paragraph. Add to this section a discussion of the relationship that exists between the Radium-226 concentrations in soil and the radon flux rates at the surface of OU-1. Include in this discussion, the approximate time frame that the radon flux rates will reach a maximum over the 1000-year study period.

77. Page 50, first, second, third, and fourth paragraphs. Add a discussion surrounding the data source utilized to determine exposure point concentrations for radon and daughter products. This discussion should summarize what is described in attachment A on this subject after responding to the comments provided for Attachment A.

3.2.5 Exposure Point Air Concentrations

78. Page 50, first and second paragraphs. Delete the first paragraph and revise the first sentence of the second paragraph to state, "Air exposure point concentrations were determined using Lake Environmental's AERMOD-View..."

79. Page 51. The last paragraph describes Table 24 as including theoretical exposure point concentrations for radon gas. However, radon exposure point concentrations for the present and the future are presented in Table 25. Clarify or revise as necessary.

80. Page 52, first, second, and third paragraphs. Summarize the information in these paragraphs into one paragraph. Move the detailed information into section 6 and consider creating a new subsection.

Table 14 Parameters Used to Estimate Potential Current Exposure

81. Pages 55 through 58, Tables 14 and 15. Add a footnote that clarifies the exposure duration for a child receptor for any residential or farmer scenario where non-cancer COPCs are being considered.

82. Pages 55 through 58, Tables 14 and 15. Add the media that is being evaluated for the off-property receptors consistent with what is presented for the on-property/on-site/landfill receptors

83. Pages 55 through 58, Tables 14 and 15. The inhalation rate presented in these tables is depicted in this table with a unit of m^3/h. Revise this rate to be consistent with the EPA PRG calculator and footnote "k" in this table, which would make it 60 m^3/day.

Table 15 Parameters Used to Estimate Potential Future Exposure

84. Page 57, Table 15. Correct the Averaging Time (At-Cancer) for carcinogens associated with the Grounds Keeper scenario from 2,550 days to 25,550 days.

85. Pages 57 and 58, Table 15. Clarify in section 3.1.5.3 that the future off-property farmer scenario was evaluated as an age-adjusted receptor consistent with the defaults assumptions in the EPA PRG and RSL calculators. Review the values reported in Table 15 for this scenario, and revise as necessary.

Table 16 Surrogate Radionuclides, Current Conditions

86. Page 59, Table 16 and Table 17: After recalculating unit risks using the updated PRG calculator, review these tables and revise as necessary to ensure that all daughter products for each parent radionuclide are listed and match with the assumptions utilized in the PRG calculator. Also revise Tables 18 through 23, correspondingly.

87. Page 59, Table 16. Clarify what is meant by the term "yield" in footnote "b," i.e. branching fraction, gamma energy, or intensity. Also, indicate the specific value that is used to determine the level below which yields are "low."

Table 17 Surrogate Radionuclides, Future Conditions

88. Page 59, Table 17. Further define what is meant by "minor branching ratios" in footnote "b."

Table 21 Future Exposure Point Concentrations for Area 1 Soil

89. Pages 62 through 64, Tables 21 through 23. Given that Lead-210 (Pb-210) will come into secular equilibrium with Ra-226 during the 1,000 year study period, review the number of Ra-226 daughters listed as being considered in the future. Revise these tables as necessary to remain consistent with the use of the updated PRG calculator.

90. Pages 62 through 64, Tables 21 through 23. Add a footnote to these tables that identifies the "future" timeframe used in this evaluation (i.e., number of years).

91. Pages 62 through 64, Tables 21 through 23. Footnote "b" mentions that the "ND" designation means that no data was available. Clarify whether this means that data does not exist for these analytes or the results were simply non-detects.

Table 25 Projected Radon Concentrations at Selected Locations from all Source Groups

92. Pages 66, Table 25. The footnote to this table states that the average annual windspeed is 4.6 m/s, while the value presented on page 42 in Appendix A is given as 4.1 m/s. Revise either the footnote or appendix using the correct value.

Figure 4 Conceptual Model

93. Page 67, Figure 4. The EPA provided comments on this figure in our previous letter dated March 17, 2017. Revise this figure to be consistent with the revisions to the draft RIA.

4. TOXICITY ASSESSMENT

4.1.1 Radiocarcinogens

94. Page 71. The second paragraph states that both dermal reference dose (RfD) and slope factor (SF) values are reported for radionuclides. Because RfD is a non-carcinogenic based toxicity factor, remove this reference or clarify and include in the table the radionuclides you are considering for a RfD .

95. Page 71, second paragraph. Add a reference in this section to the document that describes how the slope factors are calculated for the EPA PRG calculator. The reference and web access location is listed as follows:

a. ORNL (2014c). Calculation of Slope Factors and Dose Coefficients and appendix. Center for Radiation Protection Knowledge. September 2014.

b. https://epa-prgs.ornl.gov/radionuclides/SlopesandDosesFinal.pdf

96. Page 71. The second paragraph lists the unit for slope factors as grams per picocurie years (g/pCi-y). For clarity, include the units for slope factors for both soil and air, i.e. risk/yr per pCi/g for soil and risk/yr per pCi/m^3.

4.1.2 Chemical Carcinogens

97. Page 71, second paragraph. The text states that the EPA's RSL calculator cites the EPA's IRIS as the preferred source. It is important to note that the EPA uses a hierarchy of toxicity values, based on the OSWER Directive 9285.7-53. In this section, provide a discussion of the tiered approach and hierarchy that the EPA uses (referencing the OSWER Directive or the RSL User's guide, which has a full explanation of the tiered approach that the EPA uses (https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-may-2016)).

4.1.3 Noncarcinogenic Chemicals

98. Page 71. The last paragraph states,"For noncarcinogens, it is assumed that a dose exists below which no adverse health effect will be seen. Below this 'threshold' dose, exposure to a chemical can be tolerated without adverse effects."

For exposure to air, a human equivalent concentration (HEC) is converted to a reference concentration (RfC), which is an estimate of a continuous inhalation exposure to the human population that is likely to be without appreciable risk of deleterious effects. Therefore, the RfC is an air concentration, as outlined in the EPA's Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), EPA-540-R-070-002, January 2009. Revise this paragraph to include terminology that relates to exposures to air contaminants.

4.1.4 Lead

99. Page 73. The adult lead methodology has been updated recently. Refer to the comment in section 5.1.5, and revise as necessary.

4.2 Toxicity Profiles

100. Page 73, general comment. This section does not provide for the use of individual Chemical Abstract Service Registration Number (CASRN) for each chemical evaluated in Section 4.2. Add the CASRN in appropriate tables in this section in order to identify the specific chemical forms and synonyms commonly used for each chemical. Additionally, for non-cancer risk values, provide the toxicological endpoint(s) for the RfC and RfDo. This information is required to create RAGS Part D Table 9.1RME, Summary of Receptors risks and Hazards for COPCs.

101. Page 73 provides detailed information for the chemicals that are considered most prevalent in OU-1. Clarify what is meant by "most prevalent," and whether consideration was given to the maximum concentration of that chemical compared to the screening level.

102. Pages 73 through 85. For each of the chemicals discussed in this section, provide both the cancer toxicity value and the non-cancer toxicity value whenever available.

4.2.9 Chromium

103. Page 77. Please check the use of the nomenclature for the Chromium valiance states (3+ versus III). Please use consistent terms in the text of the BRA, and within the broader RIA.

4.2.11 Lead

104. Page 78, second paragraph. Clarify why the National Ambient Air Quality Standards (NAAQS) was converted to mg/kg/day, or delete the conversion statement from this paragraph. The NAAQS air standard for lead is used as an air concentration. Delete the following sentence: "The NAAQS is equivalent to 0.00004 mg/kg/day, assuming a body weight of 80 kg and an inhalation rate of 20 m3/day.".

4.2.13 Nickel

105. Page 80, last sentence. The oral RfD for nickel soluble salts is 0.02 mg/kg-day. Correct in text, which currently has the oral RfD presented as 0.002 mg/kg-day. Add the RfC value of 9.0E-05 mg/m^3 for nickel soluble salts.

4.2.16 Radon and Progeny

106. Page 82. The third paragraph presents a calculation for a slope factor for radon-222 based on the 1992 version of HEAST. This calculation was done in order to determine a slope factor for Radon-222 that does not include contribution from the daughter products. The EPA PRG calculator was updated January 2017 with new slope factors for radon and its progeny. Review the Radon Dose and Risk Coefficient Report available on the PRG website (https://epa-prgs.ornl.gov/radionuclides/RadonDoseandRiskCoefficientReport.pdf), and revise this paragraph according to the methodologies presented in this report.

Provide**4.2.19 Uranium**

107. Page 84, first paragraph. Add to this paragraph the natural uranium isotope activity percentages, in addition to the existing weight percentages.

108. Page 84, third paragraph. Use the ATSDR intermediate minimal risk level (MRL) for soluble uranium of 0.0002 mg/kg-day, in lieu of the RfD currently published in IRIS, as discussed in the December 21, 2016, memo titled, "Considering a Noncancer Oral Reference Dose for Uranium for Superfund Human Health Risk Assessments." The document and formal transmittal memo are available at: https://semspub.epa.gov/src/document/11/196808.

Table 26 Radiological Carcinogenic Slope Factors

109. Page 86, Table 26. Revise the slope factors, as necessary, to be consistent with the updated PRG calculator. The EPA notes the calculator now provides slope factors for radon and its progeny separately.

110. Page 86, Table 26. Add to the "Note" in this table, the date the PRG calculator website was accessed.

111. Page 86, Table 26. After making edits to the tables from Section 2 and Section 3, revise this table as necessary for consistency. Risk factors should be described and included in this table for individual radionuclides or specific groups of radionuclides, and the progeny considered consistent with the use of the updated PRG calculator.

Table 27 Chemical Carcinogenic Toxicity Values

112. Page 87, Table 27. Cobalt and nickel oxide have Inhalation Unit Risks (IURs) of 9.0E-03 $(\mu g/m^3)^{-1}$ and 2.6E-04, respectively (EPA RSL Table, May 2016). Add these IURs to this table.

113. Page 87, Table 27. All chemicals with toxicity profiles discussed in Section 4.2 are not included in this table. Add a discussion in Section 4.1.2 explaining why these chemicals are not present on this table.

Table 28 Noncarcinogenic Chemical Toxicity Values

114. Page 88, Table 28. Similar to the previous comment related to table 27, add to the discussion in Section 4.1.2, an explanation for why certain chemicals with toxicity profiles included in this document are not present in this table.

115. Page 88, Table 28. Revise the nickel oxide Inhalation Reference Concentration (RfC) to 2.0E-05 mg/m^3 and the Oral Reference Dose (RfD) to 1.1E-02 mg/kg-d (EPA RSL Table, May 2016). The Dermal Reference Dose (RfD_d) should also be changed accordingly. The values presented in Table 28 are for nickel soluble salts. Also, as discussed in a previous comment, the recommended RfD for uranium (soluble salts) is 2E-04 mg/kg-d (https://semspub.epa.gov/src/document/11/196808), and the RfC is 4.0E-05 mg/m^3 (EPA RSL Table, May 2016). The RfD_d should also be changed accordingly.

5. HEALTH RISK CHARACTERIZATION

5.1 Methods Used for Risk Characterization

116. Page 89. The fourth paragraph states, "The general form of the equations used to calculate health effects for each of these types of human health effects are presented in the following sections. Specific equations and pathway-specific considerations are not provided here as they are available on the previously cited web calculators and incorporated by reference." Add to section 5, wherever appropriate, the specific equations used to calculate risks in order to facilitate the use of this document as a standalone risk assessment. These equations can be copied directly from the EPA PRG websites. Revise this paragraph and other similar statements in the following sections, as appropriate.

5.1.2 Noncarcinogenic Effects

117. Page 91. The last paragraph states that exposures were evaluated using chronic RfD and 24-hour chronic RfC values. Clarify what is meant by 24-hour chronic RfC values, and provide a reference for these values.

118. Page 92. The second paragraph indicates the EPA RSL website was used to provide the calculations of risk. Discuss the forward calculation of risk, and include the respective formulae for this approach in this section. The EPA assumes that the method is to divide the media concentration by the PRG and scale to the risk at which the PRG is set (i.e. 1.0E-06 or a HQ of 0.1). (Risk = (Concentration × Target risk) / PRG). This methodology is not described in the previous sections of this document. Clarify the methodology being utilized to calculate risks for noncarcinogenic effects in this section.

5.1.3 Lead

119. Page 92, third, fourth, and fifth paragraph. For an industrial setting, the risks from exposure to lead in soil have historically been evaluated using a soil lead cleanup concentration resulting in no more than a 5% chance of a worker's fetus having a blood-lead level greater than or equal to a target blood-lead level of 10 µg/dL. However, there is increasing evidence that blood-lead levels below 10 µg/dL may have similar negative health impacts. As stated in the December 22, 2016, OLEM Directive 9200.2-167, "the current scientific literature on lead toxicology and epidemiology provides evidence that adverse health effects are associated with blood lead levels (BLLs) less than 10 µg/dL." The 2013 Integrated Science Assessment for Lead found that several studies have observed "clear evidence of cognitive function decrements (as measured by Full Scale IQ, academic performance, and executive function) in young children (4 to 11 years old) with mean or group blood Pb levels between 2 and 8 µg/dL (measured at various lifestages and time periods)(USEPA 2013)." The National Toxicology Program's Monograph on Health Effects of Low-Level Lead found blood lead concentrations <5 µg/dL are strongly associated with decreased academic achievement, IQ, and specific cognitive measures, increased incidence of attention-related behaviors and problem behaviors (NTP, 2012). In addition, the American Academy of Pediatrics stated that "low-level lead exposure, even at blood lead concentrations below 5 µg/dL (50 ppb), is a causal risk factor for diminished intellectual and academic abilities, higher rates of neurobehavioral disorders such as hyperactivity and attention deficits, and lower birth weight in children (AAP, 2016)."

As a result, until a final decision is made on the target blood-lead level to be used in evaluating risks from lead exposure, it is reasonable to use a target blood lead level of 5 µg/dL in this risk assessment. The results for Area 2 using an average soil lead concentration of 529 mg/kg, and a target blood lead level of 5 µg/dL in the updated Adult Lead Methodology are presented in the following table:

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	µg/g or ppm	529
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
$AF_{S,D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S,D}$	Exposure frequency (same for soil and dust)	days/yr	225
$AT_{S,D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	1.4
$PbB_{fetal,\ 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	5.0
PbB_t	Target PbB level of concern (e.g., 5 ug/dL)	µg/dL	5.0
$P(PbB_{fetal} > PbB_t)$	Probability that fetal PbB exceeds target PbB, assuming lognormal distribution	%	0.9%

120. Page 92, third paragraph. Delete the sentence that describes ground crews wearing personal protective equipment (PPE) to mitigate risk exposures to OU-1 soils. That discussion is not appropriate to include in a baseline risk assessment.

121. Page 92, third paragraph. Provide the data, or a reference to the data, used to calculate the average lead concentrations.

5.2 Risk Estimates for Current Exposure Scenarios

122. Page 93, first paragraph. Summarize the access controls and work practices currently in place, and reference where these controls and work practices are discussed within the RIA.

123. Page 93. The first paragraph states, "Chemical carcinogenic risks and systemic effects do not occur for current scenarios in OU-1, as the chemicals associated with the source materials are covered by rock/roadbase..." Define "source material" in this sentence. If source material corresponds to locations where RIM is at or near the surface, then provide justification for the quoted statement in this paragraph. Add additional information as to the surface conditions for the buffer zone/crossroads property. Refer, as needed, to the comments provided for section 3.2.3 Current Exposure Point Concentrations in Soil.

124. Pages 94-95, Sections 5.2.1.1 to 5.2.1.6. Recommend renumbering these sections to 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.2.5, and 5.2.6 respectively, as there is no Section 5.2.1 currently.

5.2.1.2 Hypothetical On-Property Grounds Keeper Adjacent to Area 2

125. Page 94. The fourth paragraph states, "The calculated risk from all COPCs is $2.31E^{-6}$. This risk is below the EPA target risk range of $10E^{-6}$ to $10E^{-4}$."

Revise the second sentence to state the risk is within the EPA target risk range.

5.2.1.5 Hypothetical Off-Property Resident

126. Pages 94 and 95. The word "well" is used 5 times in this section to subjectively describe risks that are below the EPA target risk range. Delete this subjective description of the risks, or provide a more definitive description, i.e. two orders of magnitude below.

5.3.1 Future Exposure Scenarios for the Landfill

127. Pages 95 and 96. Revise this section, as necessary, after responding to the comment provided in Section 3.1.5.3.

5.3.1.6 Hypothetical Off-Property Farmer - Off-Property North

128. Page 98 and 99. In the second paragraph for each of the sections that describe the risks for the future off-property farmer receptors, include exposure pathway when describing the risk contribution of an individual radionuclide, i.e. inhalation, submersion, etc.

129. Page 98 and 99. In the first paragraph for each of the sections that describe the risks for the future off-property farmer receptors, include the approximate distance the receptor is from Areas 1, Area 2, and the buffer zone/crossroad roads property. In addition, describe the relationship this distance has on the calculated risk.

5.4 Summary of Human Health Risk Characterization

130. Page 100. In order for a reviewer of this document to confirm the risk characterization, provide references in this section to the attachments that contain the data used for calculating EPCs, the ProUCL outputs, and PRG and RSL calculator inputs and outputs. Also, include a reference to the attachment that presents RAGS part D tables.

131. Pages 103 through 124, Tables 30 through 51. Revise these tables, as necessary, so that risks for each exposure scenario at each receptor location are being presented separately for Area 1, Area 2, and the Buffer Zone/Crossroads property.

Table 30 Calculated Current ILCRs, On-Property Grounds Keeper Scenario - Area 1

132. Pages 103 through 105, Tables 30 through 32. Explain why there is risk from Pb-214 (from radon) that is a beta emitter, but not for Polonium-218 (Po-218) which is an alpha emitter and is higher on the decay chain (in fact directly follows Rn-222). The footnote in the table ("c") describes Po-218 as being "unquantifiably small." Explain this terminology and how it was determined. Also see all of the ILCR Tables (30 through 50) with similar items.

Table 32 Calculated Current ILCRs, On-Property Commercial Building User Scenario - Area 1

133. Table 32 and 33. There are two footnotes for "c," and footnote "d" is not listed in the table. Footnote "b" appears to be missing in the table. See also Table 33. Correct these tables as appropriate.

6. UNCERTAINTY ASSESSMENT

6.1 Uncertainty Associated with the Areal Extent of RIM in OU-1

Page 128, first paragraph. Revise the description in this paragraph, as necessary, of the areas that comprise OU-1 to remain consistent with previous comments provided in the EPA Region 7's March 14, 2017, comment letter. In addition, the number of and boring locations for samples collected outside of or adjacent to any of the OU-1 areas should be listed. Also include a figure that displays the exposure unit boundaries being considered in the document (i.e. Area 1, Area 2, and the Buffer Zone/Crossroad property).

6.3 Uncertainty Associated with the OU-1 Conceptual Model

134. Page 129, 1st paragraph. Add a reference to Figure 4 in this section, as it discusses the conceptual model for the Site.

Page 130, 1st paragraph. State in the last paragraph of this section that exposure pathways due to potentially contaminated groundwater are not being evaluated in this BRA, and will be addressed under OU-3. Delete the sentence that begins with, "For example, receptors..." through to the sentence that ends with, "...available municipal water supply." As this example does not provide valid reasons to eliminate groundwater as a potential future exposure pathway. The groundwater pathway must not be eliminated from the risk assessment unless documentation is provided showing that the aquifer is of insufficient quality and yield, based on the EPA guidelines (EPA, 1986), to be used as a drinking water source now or in the future, and will not impact other useable aquifers. In addition, the absence of current use, or the presence of a municipal water supply or institutional controls, will not be accepted as valid reasons to exclude the groundwater pathway in a residential use scenario from the risk assessment. This section should indicate that exposure pathways related to groundwater are not being addressed in this risk assessment, but must be evaluated, as appropriate, as part of the remedial investigation work for OU-3 of the Site.

6.4 Uncertainties Associated with the Models and Values used in Risk Calculations

135. Page 130, third paragraph. Provide clarification for the following sentence, "This risk assessment presents risk results that are in the higher range of the distribution of risk but not greater than the highest risk. "

136. Page 131, first paragraph. Delete the sentence that begins, "Frequently, the amount of toxicity data..."

137. Page 132, third paragraph. The BRA states that "the risk assessment uses calculated 95% UCL concentrations, which, in the interest of health protectiveness, are in the higher range of the distribution constituent concentrations." Edit this paragraph to clarifying that the exposure point concentrations calculated for this document are 95% UCLs <u>of the arithmetic mean</u>, and not upper bound 95% UCLs. Because of the uncertainty associated with estimating the true average concentration at a site, the 95% UCL of the arithmetic mean provides reasonable confidence that the true site average will not be underestimated.

138. Page 132, fourth paragraph. This paragraph should be expanded to discuss the potential uncertainties associated with the measurements of radon flux taken at the Site which have been used as a source term for radon-222 in the document. This discussion should reference both

investigations in which these measurements were taken and the major differences between the two investigations, such as, number of measurements and changes in site conditions. Remove the words, "Coupled with the access limitations provided by the restrictive covenants" as access limitations to OU-1 of the Site have no direct impact on radon modeling or the measurements of radon flux conducted at the Site.

Table 53 Uncertainties Associated with Estimated Risks for OU-1

139. Table 53. Include additional "uncertainties" associated with the long-term half-lives of daughter products.

7. SUMMARY

140. Page 135, General Comment. Review and revise this section of the BRA, as necessary, to maintain consistency within the document after responding to the other provided comments. Of note are comments related to use of the term "CERCLA risks," comments related to the definition of OU-1, and references to the areas that comprise OU-1. Also of note are comments related to the definitions of the various categories of receptors including future "Landfill Receptors" and comments related to the calculation of exposure point concentrations or changes to exposure scenarios that may alter the calculated risk.

7.2 Ecological Assessment Summary

141. Page 136. Add a reference to Appendix B (Ecological Risk Addendum) of the BRA to this section to refer readers to the ECO Risk Assessment portion of this document. In addition, revise this section to ensure it accurately summarizes the conclusion statements as provided in Appendix B (Section B.5, page 12-13).

APPENDICES

General Comment

142. Add an acronym list for each of the appendix files attached to the BRA.

Appendix A – Air Modeling Attachment

143. A.1. Include the 0.5 pCi/L radon at the fence line ARAR/standard.

A.2.3 MEASURED RADON EMISSION RATES

144. Page 4. The last paragraph, states that the analytical results for flux were reported by a MARLAP compliant analytical lab (Eberline Service). No such compliance or certification for laboratories exists, as MARLAP is a guidance document. Revise this statement to indicate the analytical results were reported in a manner consistent with MARLAP by the analytical lab (Eberline Service).

145. Page 7. The first paragraph states that for future scenarios, the average flux values determined from the June 2016 investigation were scaled based on the ingrowth of Radium-226 from Thorium-230. Because the June 2016 measurements for flux were taken after the placement of the non-combustible cover (NCC), using the corresponding unaltered averages as an input source for the future radon flux would not be consistent with the future risk scenarios. Provide a revised source term for the current flux that is not reduced by the placement of the NCC.

146. Page 7. The first paragraph and Table A.3 presents the methodology by which radium concentrations within OU-1 currently and in the future were used to determine the relative increase in radon flux. Table A.3 shows that current "Surface Soil" EPCs were compared to future "All Soils" EPCs to determine this factor. Provide an explanation for why it is appropriate to consider radium-226 from a "Surface Soil" EPC (samples collected within the top 12 inches) to represent initial conditions for this calculation.

Appendix B - Ecological Risk

General Comments

147. The ecological risk assessment included in the document is basically a reiteration of the screening level ecological risk assessment (SLERA) performed in 2000, which concluded that all exposed ecological classes at the site may potentially be at risk. The SLERA performed in 2000 recommended further evaluation of arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and uranium. The 2016 SLERA found similar results using updated screening levels.

The EPA guidance recommends that contaminants of potential concern identified in a SLERA be carried forward into a baseline ecological risk assessment (BERA) (USEPA, 1997). This additional evaluation should have occurred after the 2000 SLERA. Since the results of the 2016 SLERA are similar. In accordance with the EPA Guidance, additional ecological evaluation at the site in the form of a BERA should be conducted; however, additional data collection is not required for the BERA activities. Instead, the BERA should include risk characterization based on slightly less conservative exposure point concentrations (95% UCLs and means), as well as, site-specific exposure factors. The BERA should also include additional risk characterization based on lowest-observed-adverse-effects-levels or lowest-observed-effect-concentrations.

The EPA is aware that, at some point in the future, the entire landfill will be covered by an engineered cap as part of required landfill closure activities. Ecological exposure at the site will change significantly once an engineered cap is installed; however, a BERA should be completed and submitted with the revised RIA and BRA.

148. The updated SLERA only considers exposures to terrestrial receptors at the site. Small areas of pooling water, as well as a drainage ditch, are present at the site. Discuss whether potential risk to aquatic and semi-aquatic receptors was evaluated in 2000. If so, present a summary and the conclusions in the 2016 SLERA. If these exposure pathways have not been addressed previously, perform the appropriate evaluations, and incorporate them into the SLERA and BERA, as necessary.

149. Discuss in the SLERA whether there is potential groundwater to surface water exposure pathways at the site that should be evaluated. The EPA is aware that a spring was previously identified on the landfill that should be considered for evaluation.

150. It is assumed that the 2000 SLERA evaluated potential risk from organics, as well as inorganics and radionuclides. Results of that screening should be discussed in the revised SLERA. If organics were not evaluated, do so now and include it in the 2016 SLERA.

Specific Comments

151. Section B.2.7:. Please provide a reference for the screening benchmarks used for radionuclides.

152. Page 19 of Appendix B. Include a title to the figure/table as provided on Page 19 of Appendix B. Suggest title by *"ECO Conceptual Site Model."*

153. Table B.5. Explain the nomenclature and intent for entry "Radium 226 +D."

154. Table B.6. Please provide the actual reference for the Uranium and Radium-226 screening levels (not the 2000 SLERA).