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

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

Dear Mr. Rosasco:

On June 5, 2020, Parsons submitted revised versions of the Design Investigation Workplan (DIWP), the Field Sampling Plan (FSP), the Quality Assurance Project Plan (QAPP), and the Data Management Plan (DMP). These documents are required pursuant to Sections 3.6(a), 5.7(a), 5.7(d), and 5.7(e) of the May 6, 2019, Remedial Design Statement of Work (SOW) OU-1, West Lake Landfill Superfund Site.

The EPA is approving, with modifications, paragraphs one through seven of Section 3.2.1 of the DIWP and the perimeter borings depicted on DIWP Figure 5. Please modify paragraphs one through seven of Section 3.2.1 and Figure 5 of the DIWP, as well as any other figures affected by these modifications, as specified in Enclosure A and resubmit to the EPA within 14 days of receipt of this letter.

The EPA is disapproving the remainder of the documents and our comments are set forth in Enclosure B. Please revise these documents in accordance with these enclosed comments and resubmit them within 30 days of receipt of this letter, as required in Section 5.6(b) of the Remedial Design Statement of Work.

As stated in Section 1.1 of the SOW, "This Statement of Work (SOW) sets forth the procedures and requirements for implementing the Remedial Design (RD) work necessary to implement the remedy set forth in the Record of Decision Amendment (RODA), West Lake Landfill Site, Bridgeton, Missouri Operable Unit 1 (OU1) dated September 27, 2018." Since execution of the Third Amendment to the Administrative Settlement Agreement and Order on Consent and attached Remedial Design SOW began, the EPA has made it clear that implementation of the RD in a timely manner is very important. However, of equal importance to the schedule in implementation of the RD are preparation of plans that are complete, based on sound science, and consistent with EPA guidance.

Many of the deficiencies described in the comments in Enclosure B point to work that is incomplete, not scientifically defensible, or inconsistent with the EPA's guidance. Further, many comments are due to the Respondents' failure to address the EPA's previous comments on the draft DIWP, FSP, QAPP and DMP (EPA letter to Respondents dated May 6, 2020.) The EPA wants to make it clear to the Respondents our expectation that successful implementation of the SOW requires that the work be complete, based on sound science, consistent with EPA guidance, and on schedule.

While the EPA recognizes the Respondents' efforts to perform the complex work necessary to prepare the OU1 RD, we have significant concerns regarding the Respondents' compliance with our mutual agreement set forth in the Third Amendment to the Administrative Settlement Agreement and Order of

Consent (Docket No. VII-93-F-0005). Please be advised that if all enclosed comments are not adequately addressed the EPA may exercise its right to modify the document. In addition, submission of a deficient DIWP may also constitute a violation of the above-referenced agreement and subject Respondents to the EPA's assessment of stipulated penalties.

The EPA believes that the best approach to move forward with the RD in an expeditious manner would be for the Respondents to inform the EPA how the identified deficiencies will be addressed and to work closely in consultation with the EPA to resolve these deficiencies prior to resubmittal of the DIWP. Please feel free to contact me with any questions or concerns by phone at (913) 551-7141 or by email at jump.chris@epa.gov.

Sincerely,

Jump, Christine

Digitally signed by Jump, Christine
Date: 2020.07.13 22:43:33 -05'00'

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

Enclosures:
A-Proposed DIWP Modification
B-Comments/Response to Revised DIWP

Enclosure A

Modifications to June 5, 2020 Design Investigation Work Plan Section 3.2.1. and Figure 5

Paragraphs 1 through 7 of Section 3.2.1 of the Design Investigation Work Plan (DIWP) and the perimeter borings depicted on DIWP Figure 5 are approved with the following modifications:

1. Delete the second sentence of the third paragraph.

2. Replace the June 5, 2020 Figure 10 that depicts the historical aerial photographs, the 1977 gamma flyover, and MDNR permit boundaries with the corrected Figure 10 previously submitted to the EPA via email dated July 2, 2020 from Ray D'Hollander, Parsons, to Chris Jump, EPA.

3. Replace the last sentence of the fourth paragraph with the following: "*In addition to radiological samples collected at depth, radiological samples will also be collected from the top 1-foot of select proposed perimeter borings as described in worksheet #11 of the QAPP and Tables 1 and 2 of the FSP*."

4. Modify by deleting the seventh paragraph of this section.

5. Modify Figure 5 as follows:

Area 2

1) Add a boring approximately 300 feet south of A2-PB-149 in the northwestern corner of permit area 218903R.

2) Add a boring approximately 400 feet southeast of A2-PB-148 perpendicular to the fence line in the northeastern portion of permit area 118903R.

3) Add a boring approximately 400 feet southeast of A2-PB-152 perpendicular to the fence line in the northeastern portion of permit area 118903R.

4) Move boring A2-PB-154 approximately 75 feet southeast from its proposed location, perpendicular to the fence line.

5) Add a boring approximately 100 feet southeast of boring A2-PB-145 along the boundary line.

6) Move boring A2-PB-145 approximately 75 feet northwest along the boundary line.

7) Move boring A2-PB-144 approximately 50 feet northeast along the boundary line toward A2-PB-143.

8) Move boring A2-PB-143 approximately 50 feet northeast along the boundary line toward A2-PB-142.

9) Add a boring approximately 100 feet southeast of A2-PB-157, perpendicular to the fence line, in permit area 218903R.

10) Add a boring approximately 100 feet southeast perpendicular to the fence line between borings A2-PB-141 and A2-PB-156.

Rationale for boring locations in Area 2: The EPA's previous comment #37 to revise perimeter boring locations based on the historical aerial photos was not limited to consideration of activities occurring only in Area 2, as the DIWP indicates (Section 3.2, 3rd paragraph, 1st sentence). The aerial photos should have been used to evaluate activities and areas at the landfill where RIM impacted material could have been placed or relocated during the time period between when leached barium sulfate residues mixed with soil were transported to the site in 1973, and when the 1977 aerial gamma survey was conducted, regardless of which side of the "boundary" they occur on. The conceptual site model (CSM) in the Remedial Investigation Addendum states that the southern boundary of Area 2 is coincident with the northern boundary of the Inactive Sanitary Landfill and the northern boundary of the Closed Demolition landfill. It goes on to say that review of historical aerial photographs indicates that activities associated with the quarry operations and landfill did occur contemporaneously across the boundary between these areas. It also states that portions of the Inactive Sanitary Landfill located near, but not adjacent to, Area 2 and a portion of the area later encompassed by the Closed Demolition Landfill were being used for waste disposal at the same time that Areas 1 and 2 were being used.

Section 1, page 1 of the January 2018 Remedial Investigation Addendum states, "*The areas of the West Lake Landfill where radiologically impacted materials (RIM) are present have been designated by EPA as OU-1."* The current boundaries depicted for Areas 1 and 2 were defined based on the boundaries of the underlying land parcels, the locations of fencing, the permit area boundaries, and review of historical aerial photographs (RIA, 2018, pg 128). No specific sampling with an objective to identify the boundary was performed; however, the CSM clearly states that the activities occurring in Area 1 and Area 2 were also occurring contemporaneously on portions of what are now known as the Inactive Sanitary Landfill and the Closed Demolition landfill, which is why the RIA states, "*During the Remedial Design phase additional sampling and evaluations to confirm the waste-cell boundaries between/near the Inactive Sanitary Landfill and the Closed Demolition Landfill are anticipated*."

An aerial gamma survey of the West Lake landfill complex was conducted in October 1977. This aerial survey identified elevated gamma readings in Area 1 and Area 2. It did not specifically identify elevated gamma readings on the Inactive Sanitary Landfill and the Closed Demolition landfill; however, the gamma survey was not conducted until 4 years after the RIM had been brought to the site, and these landfill areas were newly permitted in January 1976 and newly placed waste could potentially shield the gamma response. Therefore, based on the time

elapsed and the existing uncertainty regarding historical activities, the possibility of buried RIM occurrence south of the estimated boundary for Area 2 needs to be explored.

For these reasons, the RODA states, "*Additional samples will be collected, as necessary, during the RD phase to confirm the extent of RIM near the boundaries of Area 1 and 2 to ensure that the engineered cover is properly placed over all areas where RIM will remain on Site*" (RODA, 2018 pg 66). Based on the CSM and historical information, the EPA will require borings to be collected south of the estimated Area 2 boundary depicted on the figures to confirm the boundary between OU-1 and OU-2.

The CSM does not provide any expectation that the presence of RIM is contiguous across OU-1, and actually indicates that similar landfilling activities that were not directly adjacent to Area 2 may have occurred in the Inactive Sanitary landfill. Therefore, perimeter borings that propose to "step out" only if a detection in excess of the RIM definition occurs, regardless of historical site activities and the CSM is not sufficient.

Area 1

11) Add boring at historical perimeter surface sample location 1015S based on surficial thorium at 31.17 pCi/g.

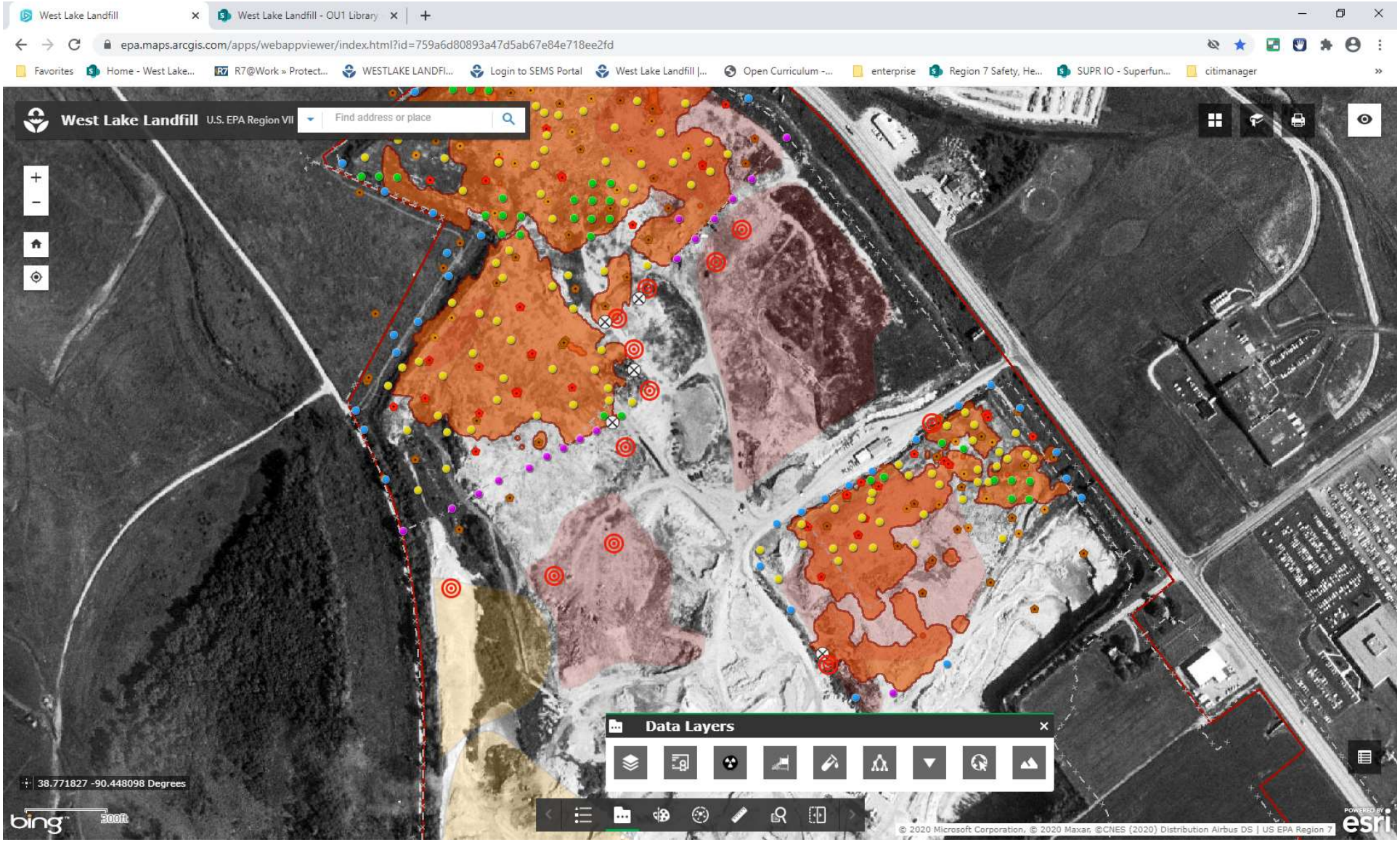
12) Shift proposed boring A1-PB-102 approximately 50 feet southeast based on historical data.

A figure is attached to depict the locations of the boring modifications.

Attachment

Enclosure A Boring Modifications

Red Bullseye represent approximate location of boring modification
White with black X represents relocated proposed boring
Orange shading depicts extent of RIM from FFS
Pink and tan shading depict approximate location of permits 218903R and 118903R
September 1973 Aerial photograph.



Enclosure B

EPA General Comments on the Revised Documents Associated with the OU-1 Remedial Design Investigation dated June 5, 2020

General Comments

1. **Inconsistencies and conflicts among the Design Investigation Work Plan (DIWP) and its appendices, the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP).** When preparing these very interrelated documents, Respondents must ensure that all pieces of the work are consistent and do not conflict with one another. In many cases with this revised set of documents, revisions were made to the section of the document identified in the EPA comment, but no effort was made to carry those changes through to the companion documents. A comment made by the EPA on any one of these documents may impact the content of one or several of the other documents. Respondents must make the necessary, consistent revisions to each of the different documents upon resubmission.

2. **Inconsistencies and conflicts between Respondents' Responses to Comments and actual changes made in the revised DIWP, FSP, and QAPP.**
    a. The "Response to Comments" (RTC) that was submitted along with the revised DIWP, FSP and QAPP, contain inaccuracies, at times significant ones, in descriptions of how certain comments were addressed and therefore were of limited benefit to the EPA. For many of the EPA comments the response was "*Revised as requested*" when in fact, that did not occur. In some instances, the revision did not happen at all, and in other instances only part of the comment was addressed. Without more detail in the RTC regarding where changes were made and a description of the changes, the RTC lacks utility. Also, in the RTC there are many cases where the response states "*Revisions have been implemented as requested*" or something similar and yet when the EPA reviewed the text revisions may have been made but they were not "made as requested". For example, previous EPA comment 43 states, "*Revise this section by adding, "as determined in coordination with the EPA," after the words, "and all data collection needs have been satisfied". Make this same revision in other sections where this language occurs, (e.g. Sections 3.1.2.2; 3.1.2.3; 3.1.3).*" The response was "*Revisions have been implemented as requested*". The actual revision in the text states, "*Once the downhole gamma scan has been conducted and all data collection activities specified in this DIWP and related documents (FSP and QAPP) have been completed, the borehole will be decommissioned by removing the casing and grouting the borehole from total depth to surface grade, in accordance with applicable state regulations as discussed in the FSP.*" In this example the revision is acceptable, but it is not "as requested". The response in the RTC must accurately reflect the actual change made to the document, <u>and if not made as requested, it should explain why</u>. (underlined for emphasis)

b. Failure to address a comment. If the Respondents do not agree with a comment made by the EPA, it is the Respondents' responsibility to make the EPA aware of the objection and propose an alternative to the EPA's position. The EPA may be receptive to an alternative approach to the issue raised in its comment but is unable to approve the alternative approach when the comment is simply not addressed. Ideally, these objections should be raised prior to resubmission of the document so that some resolution may be worked out prior to the due date for resubmission.

3. **Inconsistencies and conflicts in use of frameworks to guide sampling in the DIWP, FSP, and QAAP.**
   a. The DIWP and FSP are not consistent with the QAPP, and the use of three different frameworks to guide sampling, (i.e. Design Investigation Objectives (DIOs), Geostatistical Modeling Objectives (GSMOs), and Principal Study Questions (PSQs)), indicates that the systematic planning process has not been satisfactorily carried out, or the manner with which it was used is too complex to follow. Respondents need to evaluate these three frameworks and ensure consistency whenever there is overlap between them. In addition, as stated in comments provided below on the QAPP, all data collection proposals must be developed through the systematic planning process described in the EPA's QAPP guidance and must be included in the QAPP.

   b. Given the significant comments the EPA has provided below on the PSQs and related sections of the DIWP, the EPA expects the sampling procedures to be revised. Therefore, the EPA is not providing comprehensive comments in this comment letter on the FSP in expectation that it will require substantial revision.

   c. Each sampling objective associated with the borings must be related to a PSQ identified in the QAPP. Revise the tables in Appendix G to the DIWP to provide this clarification.

4. **Lack of necessary specificity in the deliverables.** All deliverables required for this remedial design must be very specific to the design of the remedy for this site. General descriptions of processes, procedures, studies and evaluations are of little to no benefit to the design of the remedy for this site. In the documents the EPA reviewed, too much information was presented in a general manner without the details for how it will be executed for this site.

5. **Lack of inclusion of the necessary analysis of thorium and radium distribution and thorium detection limits.** It is apparent to the EPA that significant work and additional analysis was put into revising Appendix E to the DIWP; however, the thorium and radium distribution analyses (App. E, 4.1) and the thorium detection limit analysis (App. E, 4.3) have not been accounted for in the DI documents to ensure the proposed data

collection will meet the objectives of the design. The conclusions and ramifications of those analyses for the existing model and proposed sampling protocols must be developed and taken into consideration to reevaluate the adequacy of the proposed boring locations and to make necessary revisions to the sampling protocols in the DIWP. The ramifications of those analyses must also be addressed through future modeling development along with the data collected from this investigation. The Revised Excavation Plan must document how limitations in the detection of thorium via gamma surveys resulted in modifications to the final model methodology, if necessary and in coordination with EPA.

6. **Do not use the acronym "MIK".** Use of the acronym "MIK" is misleading and should not be used in any of the DIWP deliverables or any subsequent documents. Singh, 2018, comments on SSP&A (2017), "The current Geostats Report clarifies that IK for multiple thresholds (e.g., 7.9 pCi/g, 52.9 pCi/g and 1000 pCi/g) has been used. The use of IK in this manner does not represent a form of multiple indicator kriging (MIK) as described in the literature (e.g., Lockheed Martin TM of September 25, 2017 for references). The Geostats Report makes it clear that IK (and not MIK) has been used in the current Geostats Report." The "MIK" acronym, though defined correctly as "indicator kriging at multiple thresholds" in SSP&A (2017), and in several places in Worksheet #11, is defined incorrectly on page v of the QAPP, in the "List of Acronyms". Due to the confusion, the EPA requests the removal of the "MIK" acronym entirely and using "IK" to define the geostatistical modeling that will take place at a specified threshold.

7. **Downhole Detector Behavior and Collection of Samples from Targeted Gamma Count Ranges.** The QAPP, FSP, and DIWP present a sampling strategy involving collection of laboratory samples at depth intervals with gamma counts in the range of 40,000 to 500,000 counts per minute (cpm) ("mid-range counts"). This sampling strategy is introduced in worksheet #17 of the QAPP, and the DIWP asserts that this targeted sampling will further improve correlations among radium, thorium, and gamma by increasing density of data at locations where previously acquired gamma and laboratory data have been sparse (as depicted on Figure E-1 in Appendix E to the DIWP).

   The EPA supports the goal of further improving the empirically determined relationship of downhole gamma response to combined radium and combined thorium concentrations (downhole gamma to activity relationships); however, the EPA anticipates that results from the samples collected for "mid-range counts" may not conform to the expected downhole gamma to activity relationship. This expectation is based on examination of known gamma detector behavior and the general layered configuration of radiologically impacted material (RIM) in Areas 1 and 2. The figure titled Exhibit 1 below is adapted from Borehole Logging Methods for Exploration and Evaluation of Uranium Deposits (U.S. Atomic Energy Commission [USAEC] 1967) and illustrates some of these gamma detector behaviors that may be encountered during measurements of thin (relative to

detector sample volume) layers of radioactive material. These behaviors and their relevance to the investigation include the following:

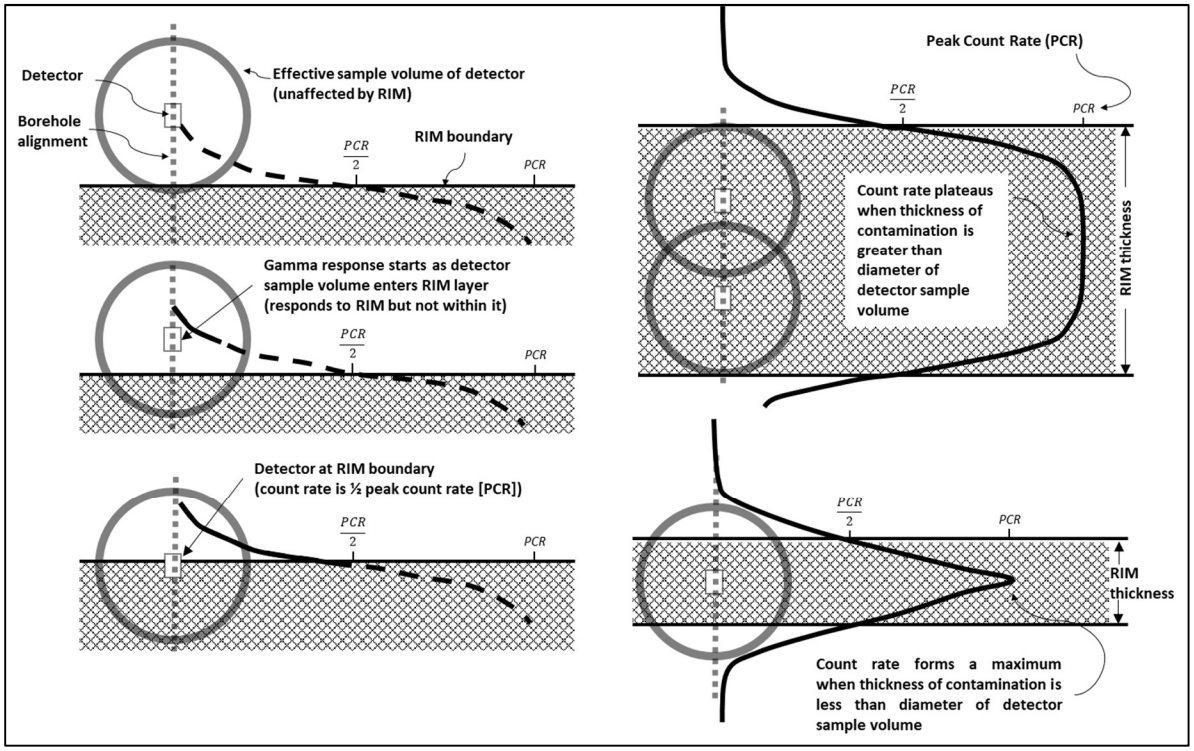
a. As the gamma detector approaches a radioactive layer, the detector responds before reaching the layer. Thus, targeted sampling of mid-count ranges, especially if the sampled interval is the midpoint of a gamma response peak, may incorporate unimpacted material into the sample—possibly not the desired outcome of design of mid-range count targeted sampling.

b. As the detector continues to approach the layer, sample volume of the detector is further filled by the radioactive layer, and count rate of the detector increases.

c. If thickness of the radioactive layer exceeds the diameter of the spherical volume the detector is sampling, the count rate will "level off" and plateau. If mid-range count intervals will be targeted for sample collection, the EPA suggests sampling intervals within which gamma responses plateau.

d. If thickness of the radioactive layer is less than the diameter of the spherical volume the detector is sampling, the count rate will spike to a local maximum. Thus, a gamma response peak with no plateau may indicate a thin (relative to detector sample volume) layer. The EPA's review of existing downhole gamma data has identified numerous spiked gamma responses with local maximums, indicating likely presence of RIM in thin layers (relative to detector sample volume). Unintended collection of unimpacted material at mid-range count intervals may be more likely within intervals with such gamma responses.

Exhibit 1. The behavior of a gamma detector as it relates to contamination boundaries. *Adapted from Borehole Logging Methods for Exploration and Evaluation of Uranium Deposits* (U.S. Atomic Energy Commission 1967)



The approach to targeted mid-range count sampling must be revised with consideration of the behavior of gamma detectors discussed above, especially if the additional data will be used to update the empirically determined relationships of downhole gamma to activity. The EPA recommends intervals with characteristic plateaued gamma responses be sampled.

8. **Improving Definition of Downhole Gamma Response Peaks.** As described in the General Comment above, as a gamma detector in a borehole approaches a radioactive layer, the detector responds before reaching the layer. Thus, the interval of a gamma response will exceed the interval of the radioactive layer. As described in USAEC 1967, true boundaries of a radioactive layer with relatively sharp boundaries can be approximated based on knowledge of the position where the detector sample volume is half filled and thus at the position of half the peak count rate (PCR), or PCR/2. From approximated upper and lower boundaries, the true thickness of a radioactive layer can be estimated. As described in USAEC 1967, this method holds for zones of radioactive contamination that are at least as thick as half the radius of the sample volume of the detector. Thus, detectors with smaller detector volumes may be able to resolve the thickness of thinner radioactive zones. Because the approximated thickness of a radioactive layer corrected for this detector behavior would provide more accurate characterization of RIM, the Respondents must identify revisions to the process that may

improve definitions of measured gamma response peaks. The EPA recommends the following:

a. Along with obtaining downhole gamma logs by use of a Ludlum 44-10 detector (which uses an approximately 2- by 2-inch scintillator), obtain downhole gamma logs using a detector with a smaller "sample volume" such as a Ludlum 44-62 detector (which uses a 0.5 by 1 inch scintillator). Downhole gamma logs obtained by use of the smaller detector may record gamma responses leading to more accurate estimates of thicknesses of RIM layers.

b. Where gamma response is encountered, increase vertical data density of downhole gamma measurements by decreasing the interval between measurements. For example, currently, readings are recorded every 6 inches, but where a gamma response is encountered, additional readings could be recorded every 3 inches.

EPA comments on the Revised OU-1 Remedial Design Quality Assurance Project Plan (QAPP) dated June 5, 2020

9. **General QAPP Comment.** The revised QAPP does not adequately address the EPA's previous comments. Comments not adequately addressed from EPA's May 6, 2020 comment letter on the first draft of the QAPP include the following: 137, 138, 140, 144, 145, 146, 147, 149, 150, 154, 155, 156, 160, 161, 164.b, 167, 175, 176, and 177. Further explanation is provided in the paragraph below and/or noted in specific comments to the revised QAPP.

In addition, some of the EPA's comments were not addressed at all in the revised QAAP, even though the Response to Comments states, "The QAPP has been revised as requested." One such topic relates to data collection "for confirming the boundaries between OU-1 and OU-2" and "predicting the lateral extent of all RIM (combined thorium and combined radium greater than 7.9 pCi/g) for the purposes of determining the placement of the OU-1 landfill cover." This deficiency was specifically discussed in the EPA's previous comments 144, 150, 155, and 161, as well as generally covered in the EPA's previous comments 137 and 149 pertaining to performing step out borings. Other topics not addressed at all in the revised QAAP include discussion of final cover application related to the Conceptual Site Model (CSM) – see the EPA's previous comment 146; a CSM discussion related to the sediment sampling – see the EPA's previous comment 147; and inclusion of specific data quality objectives for sampling related to "improving correlations/regressions between concentration of radionuclides and gamma scanning surveys" and "reducing model uncertainty" – see EPA's previous comments 149, 160, 167.

Section 5.7 of the Statement of Work (SOW) states, "*Respondents shall develop the deliverables in accordance with all applicable regulations, guidance, and policies (see Section 8 (References)). Respondents shall update each of these supporting deliverables as necessary or appropriate during the course of the Work, and/or as requested by EPA.*" (underlined for emphasis). Further, Section 5.7 (e) of the SOW lists the QAPP as such a deliverable and states, "*Respondents shall develop the QAPP in accordance with EPA Requirements for Quality Assurance Project Plans, QA/R-5, EPA/240/B-01/003 (Mar. 2001, reissued May 2006); Guidance for Quality Assurance Project Plans, QA/G-5, EPA/240/R 02/009 (Dec. 2002); and Uniform Federal Policy for Quality Assurance Project Plans, Parts 1-3, EPA/505/B-04/900A though 900C (Mar. 2005).*" Lastly, Section 8.1 of the SOW list additional EPA guidance documents pertinent to the development of a QAPP including, "*(l) EPA Guidance for Data Quality Assessment, Practical Methods for Data Analysis, QA/G-9, EPA/600/R-96/084 (July 2000), (s) EPA Guidance on Systematic Planning Using the Data Quality Objectives Process, QA/G-4, EPA/240/B-06/001 (Feb. 2006), (t) EPA Requirements for Quality Assurance Project Plans, QA/R-5, EPA/240/B-01/003 (Mar. 2001, reissued May 2006)*".

The EPA's guidance on systematic planning using the data quality objectives process states, "*Note that by properly documenting such study features as the conceptual model, analytical approach, and assumptions for collecting and statistically analyzing data, you will provide information that would be essential to ensuring that the overall validity of the study was maintained in the face of unavoidable deviations from the original design. Additionally, the documentation will serve as a valuable resource for data quality assessment activities that you will perform once the data have been collected, when you make a final determination of whether your collected data have, in fact, achieved your performance or acceptance criteria.*"

Therefore, the QAPP must be revised in accordance with the SOW and specific guidance documents referenced in the SOW to properly document the conceptual site model, as well as any assumptions for collecting and analyzing data, which necessitates discussion and planning in the QAPP for the topics discussed in the second paragraph of this comment. This will help ensure that the Respondents' proposed data collection for the DI is of sufficient quantity and quality to be used for its intended purpose. EPA has provided below additional specific comments on some of these topics and other deficiencies that further specify inconsistencies with EPA guidance.

10. **General QAPP Comment.** The EPA acknowledges the Conceptual Site Model (CSM) presented in worksheet #10 has been updated in partial response to prior comments. However, additional edits are needed in part because some of the prior comments were not addressed and also for consistency with the EPA's guidance listed in the SOW and described in the General Comment 9. "*In all projects, it is important to concisely describe all information related to the project and to provide a conceptual model that summarizes information that is currently known and how this relates to the project's*

goal." (*Guidance on Systematic Planning Using the Data Quality Objectives Process* – EPA QA/G4, 2006) This guidance further states, "*It is critical to carefully develop an accurate conceptual model of the environmental problem, as this model will serve as the basis for all subsequent inputs and decisions… Errors in the development of the conceptual model will be perpetuated throughout the other steps of the DQO Process and are likely to result in developing a sampling and analysis plan that may not achieve the data required to address the relevant issues.*" Specific comments on the CSM deficiencies in worksheet #10 are provided below in comments #17, #18 and #19.

Of further concern is that the Respondents' updates to worksheet #10 and the CSM discussion, including the expanded list of uncertainties and data gaps, did not result in subsequent development of the DQOs in worksheet #11. It is not enough to simply acknowledge the site-specific data gaps and uncertainties associated with the OU-1 design. "*The DQO Process is used to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study.*" (*Guidance on Systematic Planning Using the Data Quality Objectives Process* – EPA QA/G4, 2006) Therefore, worksheet #11 must be further developed to demonstrate that the Respondents' proposed data collection can be used for the specified purpose. Specific comments on the data gaps and uncertainties which have not been addressed, and methods to address them, are discussed in detail in comment 11 immediately below.

11. General QAPP Comment. Worksheet #10 now includes a list of ten "*Data gaps and uncertainties that are expected be addressed by the current DI…*" However, these data gaps are not yet adequately addressed by the current set of principal study questions (PSQs). Each data gap should have its own PSQ or be explicitly addressed by an existing PSQ.

a. Items 1, 2, 3, and 5 are not adequately addressed in the revised QAPP. These items are (as stated on page 13 of 156 of the QAPP): *"(1) The location and volume of RIM greater than 52.9 pCi/g between the current surface and a depth of 20 feet below the 2005 ground surface sufficient to reasonably determine an optimized excavation; (2) The specific locations of RIM significantly above 52.9 pCi/g between 12 feet and 20 feet below the 2005 surface to reasonably determine an optimized excavation; (3) The specific locations of RIM that appear to be isolated from larger occurrences of RIM between 8 feet and 12 feet below the ground surface sufficient to be accounted for in the optimized excavation;* [and] *(5) the preliminary model predictions".* Each of these data gaps/uncertainties must be clearly stated as individual PSQs or in PSQ-1 by developing sub-questions. The EPA's specific comment on those sub-questions are provided below in comment #23.i.

b. Item 8 relates to sediment concentrations in drainage areas and is already acknowledged as part of PSQ-4. Items 9 and 10 pertain to the Buffer Zone and Lot

2A2 and their relation to background which are already acknowledged as part of PSQ-2. The EPA's specific comments concerning deficiencies remaining for PSQ-2 and PSQ-4 are included below in comments #24 and 26.

c. The remaining data gaps listed include, "(4) The specific vertical intervals of RIM that have been estimated from prior borings; (6) Soft and hard data correlations/ thorium detection capability; and (7) Boundaries of Area 1 and Area 2 related either to the extent of waste (with regard to the purposes of cap design) or in some cases the extent of RIM." These items are also not adequately addressed in the QAPP.

i. For item 4, investigation and data collection are needed to estimate differential settlement since the date of sample collection given the large time gaps between the various investigations (approximately 5, 25, and 40 years prior), to evaluate the significance of this uncertainty, and to incorporate adjustments in the geostatistical model. Present-day depths of prior RIM borings and associated intervals of RIM estimated from gamma surveys and analytical samples are uncertain due to the potential for changes in elevation and topography over time as discussed in worksheet #10. This is particularly true for the borings, gamma surveys, and samples collected during the original remedial investigation which occurred in the 1990s. Though a simple adjustment was made in the prior geostatistical model for differential settlement for older sample results (SSP&A 2017), the accuracy of these corrections has not been investigated.

Worksheet #18 (p. 67 of 156) states, "*Following the topographic survey, proposed target depths will be adjusted from ft B2005GS to ft amsl through comparison of 2005 and 2020 elevation data, and will take account for the numerous periods of filling summarized in Section 2.2 of the DIWP and shown on Figures 6-12 and 6-13 of the RIA.*" Adjustment of the data in this manner adds unnecessary complexity to the design investigation. The depth adjustment which has already been made to the data introduces potentially significant uncertainty in the estimated locations of RIM in OU-1 because none of the existing data were collected in 2005 and the 2005 surface was estimated from aerial photographs rather than from a topographical survey. This uncertainty would be increased by performing the proposed second adjustment of the data after measuring the 2020 surface.

Rather than performing a series of below ground surface depth adjustments on the existing sample data, <u>elevation</u> adjustments to the existing data set should be considered only after collecting data to estimate changes in the elevation of RIM (in ft amsl) for borings from each investigation time frame between the present day and the date of sample collection. To estimate the amount of settlement since sample collection, prior borings should be selected and re-analyzed by comparing to borings drilled a short distance away. The difference between present day elevation at peak concentrations and the original elevation at peak concentrations

at the date of sample collection should be measured. The analysis should include plots showing these differences over space, spatial trend analysis, goodness of fit tests, and/or a confidence interval for the mean paired difference between past and present peak RIM elevations. This analysis must be completed in order to estimate the depth adjustments needed to use older data in the present-day model. The EPA is also aware that some PVC pipes were installed in a small number of previous borings that may allow for certain borings to be relogged utilizing the same downhole gamma logging procedures that will be used for the proposed additional borings. Develop DQOs for this data gap within worksheet #11 for each step of the DQO process. This will result in a detailed plan to obtain the necessary data (step 7). Incorporate procedures into the FSP for the data collection associated with this uncertainty. Lastly, revise any related discussions in the DIWP including Section 2.2 - *Elevation Standardization for Design Investigation Data Collection* to ensure consistency with QAPP and FSP.

A separate issue is estimation of the difference between the 2005 and present-day ground surfaces. This is relevant for meeting requirements of the RODA to remove the total amount of activity between 0 and 16 feet B2005GS, but this should be considered separately from the evaluation of differential settlement. Given that "*the majority of Area 1 and the majority of Area 2*" were closed in 1974 (see section 3.3.1 on page 25 of the Remedial Investigation Addendum), the EPA does not expect significant settlement to have occurred since 2005. In addition, the original feasibility study, which was written in 2006, states on pages 41, 75, and summarizes on page 121, "*Based on the fact that landfilling of the portions of the West Lake Landfill in which Areas 1 and 2 are located was completed approximately 30 years ago, differential settlement is not a concern because the majority of the differential settlement and compaction of the refuse has already occurred.*"

However, additional inert fill materials were placed in Areas 1 and 2 after 2005 pursuant to the Materials Management Plan (EMSI, 2006, *Materials Management Plan*, West Lake Landfill Operable Unit 1). As stated on page 50 of the Responsiveness Summary attached to the RODA, "*The Plan states that "placement and stockpiling of suitable fill material can be conducted in a manner that will be consistent with whichever remedial alternative that may be ultimately selected for the Site." Since that time, the EPA has considered partial excavation of RIM based on depth. The EPA has consistently required the depth criteria be measured from the 2005 topographic surface to ensure that these remedy alternatives and the Amended Remedy are not impacted by the placement of this inert fill.*"

Therefore, the investigation of changes to the OU-1 surface since 2005 should focus on the placement of fill material discussed in the paragraph above and could be performed by determining the thickness of the inert fill added. Develop DQOs

for this data gap within worksheet #11 for each step of the DQO process. This will result in a detailed plan to obtain the necessary data (step 7). Incorporate procedures into the FSP for the data collection associated with this uncertainty. Lastly, revise any related discussions in the DIWP including Section 2.2 - *Elevation Standardization for Design Investigation Data Collection* to ensure consistency with QAPP and FSP.

ii. For item 6, the EPA believes that more careful co-location of hard and soft data in consideration of general comments provided above on downhole gamma detector behavior (comments 7 and 8) has the potential to improve the understanding of the relationship between gamma and radium, and by extension possibly improve the understanding of the relationship between gamma and thorium. Additional data collection for regression improvement must be part of its own PSQ, or possibly a sub-question within PSQ-1. In order to make the additional data collection worthwhile, it must be explicitly stated how the new data collection will have improved confidence that the pairs truly are co-located as part of Step 3 of the DQO process. For Step 4, it should be described how truncation limits for each regression will be determined (see comments 23 and 35). Step 5 should include discussion of what criteria will be used to potentially remove data from the regression analysis. While Step 6 typically involves specifying acceptable precision, which in this case is related to the noise in the regressions, there is an unknown amount of noise that will always be present and cannot be controlled. Step 6 should instead discuss how the precision will be optimized to the extent possible. Revise worksheet #11 according to the comments above.

   The Respondents represent that the analysis presented in Section 4.3 of Appendix E of the DIWP appears to demonstrate "*the thorium concentrations estimated from gamma above 52.9 pCi/g are reasonably approximated for the multiple indicator kriging process.*" However, also stated in this section is that the radium-thorium-gamma "*relationship needs to be explored further with the collection of additional data by sampling in regions where radium has been estimated between 7.9 pCi/g and 52.9 pCi/g*." Therefore, some uncertainty remains as to whether gamma data can reliably predict thorium at concentration as low as 52.9 pCi/g and the actual prediction level could be closer to 200 pCi/g. Given this uncertainty, the EPA has provided suggestions in comments to worksheet #11 below on how to adjust the approach to sampling which is currently informed primarily from gamma scans on recovered core materials (Comment 12).

   In addition, the potential exists that after additional data collection, the gamma/thorium regression will not improve. Assuming that the understanding of the radium/thorium relationship does not improve with additional data collection, and that thorium at concentrations as low as 52.9 pCi/g is not reliably predicted from gamma measurements, the use of gamma measurements may have to be limited in the model for the prediction of thorium. Given these potential

limitations and necessary improvements to the CDF development process, the EPA has also provided suggestions on how to develop the final model before the final excavation plan is submitted. (see Comment 35).

iii. For item 7, a new PSQ or sub-question within PSQ-1, must be developed and the DQO process completed in full for this PSQ. Since the boundaries of Area 1 and Area 2 are uncertain and have a decision impact, the DQO process needs to be carried out in full for this objective to meet the EPA's guidance and ensure that the "*data are of sufficient quality and quantity to support the goals of a study*" (EPA 2006a). Step 2 should specifically define the goal of the perimeter boring program, and Step 5 should specifically describe how the proposed perimeter borings and step out process will be used to meet the objective. Steps 6 and 7 should clearly define step out criteria, step out distances, and stopping criteria. Details should include the range of gamma counts that warrant the collection of additional data from step out locations, specifically what data will be collected at what depths, as well as numbers of hard data samples. It should also be clearly stated how any hard data will be interpreted in relation to determining step out locations (i.e., what range warrants stepping out). Because gamma surveys cannot be reliably used to identify combined thorium concentrations as low as 7.9 pCi/g, any gamma result distinguishable from background could potentially indicate RIM (>7.9 pCi/g). Therefore, step out borings and sampling locations cannot be determined solely from gamma scans. The approach to sampling must consider this limitation when developing the steps of the DQO process for this PSQ.

12. General QAPP Comment. Worksheet #18 specifies the number of analytical samples that will be collected for each boring but does not specify how sample depths will be determined. General references to the FSP are made related to the drilling and soil sampling procedures; however, the FSP will need to incorporate sampling procedures informed from the updated DQO's in response to the comments provided for the revised QAPP. The sample depth, or specific procedure for depth selection, needs to be described prior to data collection in the context of the boring purpose and PSQ it relates to. This is part of Step 7 of the DQO process, "Develop the Detailed Plan for Obtaining Data" (EPA 2006a). For borings related to determining the necessary extent of the engineered cover, for example, sampling depths should be selected using an approach geared towards the performance criteria and should preferably incorporate randomness. For borings related to determining the optimized excavation, the EPA recommends using one of two approaches: 1) systematic sampling by choosing a random start location in the first core scan interval and sampling at the same location within each core scan interval as long as that specific interval is identified as an area with high kriging standard deviation or 2) by using the Kriging Standard Deviation (KSD) approach to subset the three dimensional surface to areas that have high kriging standard deviations, and randomly selecting locations within that surface. The EPA is willing to consider other potential sampling approaches as long as the approach is developed by application of the DQO process

required in the guidance documents referenced. If item 6 discussed in the previous comment is not designated as its own PSQ, then PSQ-1 would also need to address item 6 as a sub-question. The associated data collection for this data gap would then need to be considered separate from samples collected according to either of the approaches recommended above.

The EPA agrees that gamma surveys can be used to select biased sampling locations including the specific gamma interval targeted for the purpose of improving soft data regressions. It is important not to rely only on gamma surveys for determining hard data sample locations because of the remaining uncertainty in the reliability of gamma surveys to detect combined thorium at concentrations as low as 52.9 pCi/g discussed in the previous comment. The EPA's concern is that sampling informed only from gamma scanning has the potential to miss significant thorium activity. Sample selection for characterizing the extent of RIM at concentrations greater than 52.9 pCi/g must incorporate randomness with the explicit purpose of meeting performance objectives.

To address this comment, revise worksheet #18 of the QAPP (and any portions of the FSP and DIWP that describe sampling methods and/or depths) to be consistent with the sampling approaches that will be developed through the DQO process and subsequent revisions to worksheet #11 of the QAPP.

13. **General QAAP Comment.** Revise the QAPP to specify which radionuclides will be reported by the radiological laboratory for samples analyzed by EPA Method 901.1 or any other gamma spectrometry methods. In addition, revise the QAPP to specify any assumptions that will be made by the laboratory regarding secular equilibrium when reporting these radionuclides.

14. **General QAAP Comment.** Section 3.0, page 3-1, of the Design Criteria Report states "*Depending on the nature and scope of the OU-1 Design Investigation, additional air impact control and mitigation procedures may be necessary during the investigation field activities. It is anticipated that any such procedures, if needed, will be further defined in the DIWP and executed and reported in the subsequent RD deliverables*." No air monitoring, impact control or mitigation procedures were found in the QAPP or FSP. Revise the DIWP to clarify whether the DI will require any air impact control and mitigation procedures or related contingencies and if so, include them in the DIWP, QAAP and/or FSP as appropriate.

15. **General QAAP Comment.** The draft 30% Design introduces a number of new models that will be used for the design of the engineered cover and other aspects of the design. These models must be evaluated to determine if any model parameters/inputs would be informed from site-specific data collection. Specifically, the proposed geotechnical investigation objectives must be considered and updated if site-specific data collection

would benefit calibration of these new models. In such a case, DQO's defined in the QAPP related to data collection must be added.

16. **List of Acronyms, page v.** Add this footnote to the Radiologically Impacted Material (RIM) definition: "*RIM is defined in Section 5.5 of Part II of the RODA and pertains to concentrations of radium, thorium, and uranium isotopes. As stated in the RODA, RIM will be identified as waste material containing combined radium (radium-226 plus radium-228) or combined thorium (thorium-230 plus thorium-232) at levels greater than 7.9 picocuries per gram*."

17. **Worksheet 10 – Conceptual Site Model.** As described in General QAAP Comments 9 and 10 above, some of the EPA's prior comments provided for worksheet #10 were not addressed. These comments include portions of the EPA's previous comments 144, 146, and 147. Topics not addressed include:

(1) a complete description of the conceptual site model with respect to RIM placement which includes a discussion of the potential for RIM to have been placed as final cover operations given the substantial amount of RIM present at the surface of OU-1.

(2) a description of the existing investigations and data to provide context and rationale for the listed data gaps/uncertainties (includes specific items such as estimated volume of all waste in Area 1 and Area 2 and metrics such as average acreage represented by each boring and average volume represented by each sample), and

(3) a CSM discussion and associated description of data gaps related to sediment sampling.

The Response to Comment for each of these comments erroneously states, "*The QAPP has been revised as requested.*" The EPA reiterates its previous comment 144, "*This worksheet contains the only formal discussion of the CSM related to the DIWP deliverables and must be revised to provide a reasonable understanding of the data gaps and uncertainties that the DI is intended to address. This will also allow DQOs to be developed that ensure data quality is sufficient to address necessary aspects of these data gaps*." Revise worksheet #10 to appropriately address these topics (1), (2) and (3) described in this comment.

18. **Worksheet #10 – Conceptual Site Model, page 12, first paragraph.** The revisions made to worksheet #10 to address the EPA's previous comment 145 (related to "*the nature of RIM and in particular the prevalence of Th-230*") are not adequate because they do not include enough specific information to understand that Th-230 is (1) not in secular equilibrium with either U-238/U-234, (2) Ra-226 is not in secular equilibrium with Th-230, and (3) existing data demonstrate Th-230 to be present at much higher concentrations than either uranium or radium. Revise this paragraph so that it describes

the distribution of radionuclides present at the site, why this creates challenges with field characterization, and the significance of this challenge for the design of the remedy.

19. **Worksheet #10 – Conceptual Site Model, page 13, second paragraph.** Following the second sentence of this paragraph, add these sentences: "*Following excavation, the remedy requires the construction of an engineered cover meeting UMTRCA standards (as described in the RODA) over portions of the Site where RIM remains. Data gaps related to defining the extent of RIM (combined radium or combined thorium above 7.9 pCi/g), and thus the extent of the engineered cover (or "UMTRCA cap"), are addressed in this DIWP and QAPP.*"

20. **Worksheet #11, General Comment.** In Steps 3, 4, 6, and 7, it is difficult to locate the content for each PSQ, and as a result it is not clear whether the DQO process has been completed for certain PSQs. Revise worksheet #11 to improve the organization so that the discussion for each PSQ can be easily found within each step.

21. **Worksheet #11, General Comment.** Development of Step 6 must include estimation questions in terms of decision errors and performance criteria. The EPA's guidance (2006a) states that an assessment and discussion of decision error rates or uncertainty estimation should be applied to all PSQs, whether they are decision or estimation questions. For example, a 95% confidence interval is often used to address uncertainty in the common estimation question: "what is the mean concentration of constituent X in area Y?" EPA (2006a) also states that standard errors can be used as performance criteria for estimation questions. Revise step 6 for each of the existing PSQs which are proposed as estimation statements to specify performance criteria.

In addition, Step 3 in worksheet #37 (page 149 of 151) states that all the PSQs except PSQ-2 "*are estimating questions and are not subject to hypothesis testing*" and so no assumptions associated with statistical methods are listed and verified for the other PSQs. Once the direction provided in the paragraph above for Step 6 in the QAPP is performed, evaluate the assumptions associated with the statistical methods, such as the standard error or confidence interval, that are developed for all estimation PSQs in order to validate the statistic used for uncertainty estimations. For example, t-based confidence intervals rely on the assumptions of independence and normality, just as one- and two-sample t-tests do.

22. **Worksheet #11, Step 1, page 16.** A paragraph was added to the end of the "***Describing the problem***" portion of step 1 of the DQO process in response to the EPA's previous comment 149. This paragraph does not address the prior comment and additional revisions are necessary in order to include "*a description of the problems that are to be addressed through data collection during the DI*" as previously requested. Specific deficiencies to be addressed in the revisions are as follows:

(1) The prior comment 149 stated, "*This problem description should include an acknowledgement that there are some uncertainties and limitations associated with the existing data set that impact the existing geostatistical model's ability to accurately predict occurrences of RIM sufficient to design the optimized excavation portion of the remedy.*" The portion of this statement starting from "*there are some…*" was added to the paragraph verbatim; however, the intent of the comment was not simply to provide a modification to the QAPP. Rather, the comment was meant to provide a general description of a group of specific items that the Respondents should add to this section as they pertain to Step 1 of the DQO process. Several data collection proposals have been described in the QAPP or the DIWP specifically for the purposes of improving the accuracy of the model predictions. This section must be revised to generally describe these limitations such that the need for the proposed data collection is established.

(2) The EPA's previous comment 149 provided a list of four problem descriptions, three of which were specific and the last of which was general. The first item which relates to determining the drilling depth for borings and the depth interval from which to collect samples from recovered core materials was not addressed. However, the response to the comment erroneously states, "*the QAPP has been revised as requested.*" The QAPP and the DIWP have proposed to determine the drilling depths after completing a present-day topographical survey and comparing this to an estimate of the 2005 surface presumably obtained from aerial photography. Therefore, it appears to the EPA that this is a problem that is going to be solved through data collection (measurement of the 2020 topographical surface and estimated 2005 surface) obtained during the DI. In addition, the FSP currently proposes to collect samples from within depth intervals that will be identified after completing this present-day topographical survey and from specific depths within those depth intervals after performing gamma surveys on the recovered core material. The identification of hard sample locations also appears to a problem to be solved with data collection. These problem descriptions must be added to this section or explanation provided to the EPA why this is not necessary.

(3) The last problem description provided in the EPA's previous comment 149 was general and states, "*any other decision points, e.g., deciding to perform a step out boring that will be based on either soft or hard data.*" The comment was intended to direct the Respondents to list any other decisions that would be made through data collection during the DI based on either soft or hard data. One such example of a data driven decision that the Respondents have proposed is the performance of step out borings. Revise the section by describing each problem that is to be solved through data collection.

23. Worksheet #11, PSQ-1, General Comment. The EPA's previous comment 150 directed the Respondents to revise and expand PSQ-1 and the description of the contamination concern map (CCM) to "*ensure all the purposes of the CCM for this design are addressed.*" In addition, the EPA recommended "*a separate PSQ be developed*

specifically related to the ability of the CCM to reasonably estimate activity as required in the RODA." However, the revision to PSQ-1 neither recognizes these specific additional purposes nor provides a basis for the meaningful development of the subsequent steps of the DQO process. This is primarily due to the overly broad and non-specific nature of the change to the PSQ which is now stated as, "*What is the spatial and depth distribution of the activity concentrations within Area 1 and Area 2 as related to the RODA?*" the EPA's recommendation related to development of a PSQ for the RODA required activity estimates was not incorporated.

Revise the QAAP to define PSQ-1 more specifically so that performance and acceptance criteria can be defined in Step 6 of the DQO process.

a. This could be accomplished by either creating multiple PSQs or creating sub-questions within PSQ-1. The EPA's recommends breaking PSQ-1 into at least two subparts so that the DQO process can be carried out for each subpart. The QAPP needs to address all the purposes of the CCM that will be informed from data collection:
    i. Extent estimation at the 52.9 pCi/g threshold. This PSQ will be used to (1) demonstrate conformance to the RODA requirement to generally remove RIM > 52.9 pCi/g from surface to 12 ft B2005GS, and (2) define spatial boundaries of the optimized excavation in (ii). This necessarily includes the extent of any deeper excavations below 12 feet and isolated pockets between 8-12 feet that will remain in place. RIM > 52.9 pCi/g refers to either combined radium or combined thorium exceeding 52.9 pCi/g.

    ii. Optimization of the excavation in order to implement the remedy in the RODA to remove a total amount of radioactivity equal to the radioactivity from the surface to 16 feet B2005GS within the extent defined in (i).

b. Performance and acceptance criteria must be defined for each suggested subpart of PSQ-1. For an estimation question, EPA (2006a) describes Step 6, "*Develop performance criteria for new data being collected or acceptable criteria for existing data being considered for use.*" Step 6 currently contains information related to the analytical approach for PSQ-1.
    i. For extent estimation, Appendix E of the revised DIWP gives target error rates depending on the probability of RIM (Table E-3). Step 6 in the QAPP must include a discussion of the rationale for these error rates. After sampling and subsequent analysis, the target error rates can be evaluated by recalculating kriging standard deviations and evaluating the extent of regions that are uncertain with respect to excavation decisions and RIM delineation. In other words, this analysis will show to what extent the number of locations with unacceptably high standard deviations decrease after sampling. With any study, it is possible that the variation might be more than expected, and the true error rates might be larger than

those targeted (i.e., some locations with standard deviations above those targeted remain). While the constraints of the study make defining a target range particularly difficult, it is important to nevertheless set target criteria and evaluate those criteria after sampling takes place.

ii. Ideally, a similar exercise would be carried out for the activity estimation as well. As stated in comment 1 in the EPA's letter dated February 13, 2020 regarding the Preliminary Excavation Plan, "Substantial additional complexity for the development of the RD excavation is introduced with the inclusion of a second model for activity estimation." The EPA expects that this model will be evaluated and developed similarly to the Indicator Kriging (IK) model during the RD process. The approval condition associated with comment 32.c. from the February 13 letter required the consideration of the unclear statement from Appendix B of the PEP which reads, "*These values include small unverified anomalies that may be defined by an isolated sample and/or larger isolated pockets*" to determine whether a sampling objective is necessary in the DIWP. Respondents should state whether a sampling objective was determined to be necessary.

c. The text currently in step 6B of PSQ-1 is simplistic and does not address many assumptions and potential problems with the methodology. This section must be revised. Specific deficiencies and concerns include the following:
   i. If data used to develop a regression are truncated, it must be done so by the range of the predictor, not the response. The QAPP states "*when radium is between 2.8 and approximately 10 pCi/g, the corresponding thorium may be either: less than 52.9 pCi/g (when not correlated to radium), or correlated to radium when in the range of 52.9 to approximately 200 pCi/g*" (p. 29 of 156). This statement does not make sense. Thorium is either correlated to radium in this range or not. Therefore, radium concentrations in the 0 to 10 pCi/g range may not be capable of predicting thorium if no correlation exists. Strictly following this logic, and figures E-12 through E-14 in Appendix E of the DIWP, thorium concentrations below about 200 pCi/g may not be reliably predicted from gamma count data. The gamma count that corresponds to 10 pCi/g radium should be determined and used to establish a "*regression threshold*" below which thorium cannot be predicted from gamma data. (See comment 35 for additional recommendations about how to modify the modeling approach in the future if radium is not correlated to thorium below 200 pCi/g).

   ii. The EPA has provided several significant comments on analyses and information presented in Appendix E of the DIWP which include comments related to the radium-thorium-gamma relationship. These

comments must also be addressed in the QAPP and in PSQ-1 to the extent they relate to additional data collection or identify deficiencies in the approach to sampling. Comments related to future modeling development do not need to be addressed in the revised DIWP. The EPA expects to continue the coordination process with the Respondents' geostatistical modeling team on the future development of the model until the submission of the Revised Excavation Plan.

iii. The QAPP states that "*since the activity balancing is more influenced by concentrations significantly higher than 52.9 pCi/g, the effects of the lower accuracy of the gamma at the lower concentration will have no impact on the results of the optimization*" (p. 29 of 156). The EPA does not agree with this statement because an inaccurate gamma-thorium regression model may under-predict thorium and omit important pockets of high thorium concentrations from the RIM shell given by the extent model. In addition, previous analysis performed by the Respondents have indicated that the majority of the volume of RIM consists of material at the lower concentration ranges. Thus, the volume of the excavation and extent to which the excavation has been optimized are likely directly related to this uncertainty. Lastly, the activity model depends even more heavily on the regressions, because they are used without taking into account their uncertainty. The EPA has provided additional comments with direction on how to properly account for uncertainty in thorium concentrations when observed gamma counts are below the threshold at which thorium concentrations can be predicted. (See comment 35 for additional recommendations about how to modify the modeling approach if radium is not correlated to thorium below 200 pCi/g).)

24. Worksheet #11, PSQ-2, General Comment. This PSQ is stated as follows, "*Do radionuclide concentrations in the Buffer Zone and Lot 2A2 exceed background?*" A two-sample t-test is proposed to answer this question, which tests the equivalency of means assuming equal variances. This is distinct from comparing site concentrations to an action level, which is a known constant. Table 11-3 should be revised to state that an action level is not applicable for this question, Revise the alternative actions to specify that if the analysis concludes site concentrations are statistically greater than background (e.g., the site mean is statistically greater than the background mean), action is needed. If action is needed, the DQO process will need to be re-started in order to answer the new estimation question of the spatial distribution of contamination in order to perform the necessary excavation of contaminated portions of the Buffer Zone and Lot 2A2 and to determine whether disposal should occur off-site or on-site. This approach is consistent with the direction provided in the EPA's previous comment 152 which states, "*data collection must first occur to characterize the occurrences of RIM on the Buffer Zone and Lot 2A2*

to determine where or whether remediation is needed according to the requirements in the RODA.

In step 7 (p. 33 of 156), the QAPP states "*This question is answered by 1) determining statistically valid mean background concentrations of ROCs, 2) determining mean concentrations of ROCs in DUs, and 3) comparing the means*", which implies the raw means will be compared rather than conducting a valid statistical test. This implication is also found in other areas of the document (e.g., worksheet #37 step 4). The QAPP must be revised so that the approach to PSQ-2 is clear and consistent throughout the document.

Radionuclide data can be highly skewed, such that the mean site concentration may not exceed background, but the upper quantiles of the distributions might still be elevated. The quantile test determines if the p^{th} quantiles of the two distributions are equivalent (EPA 2006b). Most commonly, the 75^{th} quantile is tested (EPA 2006c). Perform a quantile test in addition to testing the centers of the distribution to develop a clearer understanding of the distributions of each of the Decision Units (DU) and background. In addition to the t-test and quantile test, perform a sanity check comparing the distributions to inform the need for action. For example, while a DU might pass both tests, the maximum site concentration could be an order of magnitude (or more) above background. In such a case professional judgement should be used to determine whether further characterization is necessary.

The analysis of decision units must be performed separately for the Buffer Zone and Lot 2A2. In addition, the role of depth in the sampling plan is unclear. The QAPP states that two different depth intervals from each location will be taken for both background (p. 33 of 156) and site data, with a third interval taken from site locations if "*impacts are observed*" (p. 65 of 156) in the second interval. The result that constitutes an impact must be defined. If an impact is observed, the purpose of sample collection becomes characterization rather than background comparison, and sample locations chosen preferentially should not be used in the background comparisons so as not to bias results. Further, depth must be accounted for in the analysis, especially if results are expected to be more similar at the same depth. Simply pooling the background and site data across all depth intervals would result in a violation of the assumption of independence, especially if a spatial correlation is observed. Comparisons between the Buffer Zone and Lot 2A2 Decision units to background must be made for each depth interval.

Revise step 3 of worksheet #37 to include a more thorough explanation of the assumptions for PSQ-2. The assumption that the site data and background data are independent from one another is missing. This should be evaluated in a conceptual manner by discussing the adequacy of the background areas (i.e., they are not affected by any contamination present in the Buffer Zone or Lot 2A2, the soil types are similar, etc.). See comment # 73 below on section 3.2.4.2 in the DIWP for additional direction regarding the selection of background locations. For homogeneity of variances, either a

visual comparison or a formal test of equal variance should be performed. Finally, some attempt should be made to identify alternative actions if the assumptions are not met. For example, if the data appear non-normal, a non-parametric test should be used. The Wilcoxon Rank Sum test (or if there are non-detects, the Gehan test) should be used to test differences in the medians (EPA 2006b). Less commonly, a permutation test could be used to test differences in the means (Ramsey and Shafer 2013).

25. Worksheet #11, PSQ-3, General Comment. This PSQ is stated as, "*What are the baseline concentrations of constituents in groundwater in Areas 1 and 2?*" Since groundwater monitoring will be implemented separately from the rest of the DI and has not been fully developed at this time, the OU-1 groundwater monitoring and development of associated DQOs may be more appropriate to include in either the Site Wide Monitoring Plan, a specific section in the OU-3 QAPP that deals directly with OU-1, or submitted as a separate addendum to the DI QAPP. Comments on this PSQ are provided here but the revision to the DI QAPP need not include a revised PSQ-3 at this time. However, the revised DI QAPP must include a statement explicitly defining which document will include further development of PSQ-3 for OU-1.

Regardless of which plan contains this PSQ, it needs to address comments 32 and 33 below on PSQ 3. (In Step 5 of worksheet #11, revise to clarify what is meant by "*statistical limits*".) Also revise to clarify whether confidence limits will be computed, a trend analysis over time will be performed, or some other spatial analysis will be completed. Include definition of the statistic(s) that will be estimated and the method(s) for uncertainty quantification. For example, an overall mean could be computed for each area with a 95% confidence interval. In Step 5, describe how the results will define a future monitoring plan.

26. Worksheet #11, PSQ-4, General Comment. This PSQ is stated as, "*Are there historical impacts present in sediments of drainage areas and the northwest, or NW, surface water body*?"

a. The EPA's previous comment 154 states, "*The PSQ must be revised so that there is consistency between it, the alternative actions, and the estimation/decision statement presented in Table 11-1.*" The revisions to the PSQ have not provided this consistency. The PSQ states "(*estimate*)" after definition in Table 11-1, yet the alternative actions are presented as if for a decision question. This is further complicated by Table 11-3, which presents an estimation alternative action for PSQ-4. Revise to provide clarification on whether PSQ-4 is a decision or estimation statement.
b. Similar to PSQ-3, the parameter of interest that will be used to assess present day impacts needs is not currently defined in Step 5 of the DQO process. EPA (2006a) states that Step 5 involves defining the "parameter of interest", specifying the "type of inference", and "developing the logic for drawing conclusions from

findings". Revise worksheet #11 to describe tools for exploratory data analysis and statistical calculations that will be performed.

c. The EPA's previous comment 154 states, "*it is not clear how the determination will be made as to whether an [historical] impact has occurred."* Revise worksheet #11 to provide constraints defining what constitutes a "historical impact" in Step 4, and as discussed in "b" above define the parameter of interest in Step 5. If this question will be approached by sampling from the most likely areas of contamination to identify an impact, the threshold for determining an impact must be stated, and the physical evidence justifying the sample location must be thoroughly explained. Alternatively, if this question is more of an exploratory analysis of potentially impacted areas, worksheet #11 should describe tools for exploratory data analysis and statistical calculations that will be performed, if appropriate.

27. Worksheet #11, PSQ-5, General Comment. PSQ-5 is stated as," *What are the concentrations of constituents in leachate in Areas 1 and 2*?" Similar to PSQ-3 and PSQ-4, revise worksheet #11 to define the parameter of interest and the method for uncertainty estimation. It should be clear whether a mean concentration will be estimated, a distribution of concentrations will be characterized, or some other spatial or temporal analysis will be done.

The Respondents have discussed in the DIWP that the volume of leachate that may be encountered during the excavation will be evaluated through performance field test from seven proposed standpipe wells to be gauged monthly. The QAPP should discuss this data gap/uncertainty in worksheet #10 and develop DQOs for this data collection in worksheet #11. Because the Respondents have proposed data collection from seven different locations monthly over a one-year period, the DQOs should discuss the apparent temporal and spatial evaluation this data collection is intended to estimate.

28. Worksheet #11, Step 2, related to EPA previous comment 156. The QAPP was revised by removing what was formerly Figure 11-1; however, this does not address the comment which states, "*The EPA believes that a diagram that visually depicts the steps/decisions that are specific to the DI would be useful. Revise this figure after updating the statement of the problem and PSQs according to the prior comments.*" Upon further consideration, and in the interest of moving forward efficiently, as long as the remainder of the comment ("…t*hen include in the diagram the steps for locating the depth of samples within specific borings, the approach to making decisions to collect an additional step out boring, and any other decisions or estimates that will be made specifically related to the DI.*"), and other related comments in this letter, are addressed in the text of the revised QAPP, such a diagram will not be required.

29. Worksheet #11, Step 4. Define the Boundaries of the Study, page 23. The EPA's previous comment 161 states, "*The description of the site boundaries and <u>their</u>*

relationship to existing fencing is overly simplistic and is not consistent with other aspects of the DI." (underlined for emphasis) The revision contained in this QAAP related to the description of the Site fencing, as well as the Site boundaries, do not adequately address the EPA's previous comment.

Respondents must delete the statement "*Areas 1 and 2 are surrounded by fencing which makes the approximate OU-1 boundary easy to visually distinguish*." and replace the statement with "*Although the Site boundaries reflecting Areas 1 and 2 have been previously estimated (EMSI 2018), data collection is proposed to determine the extent of RIM and waste for the purpose of confirming the OU-1 boundaries and placement of the engineered cover required by the RODA.*" The EPA does not agree that the boundaries of Areas 1 and 2 are easy to visually distinguish nor do existing fences "*makes the approximate OU-1 boundary easy to visually distinguish*" because the existing fences are not contiguous with the estimated Area 1 boundary. The EPA's concerns include (1) the western and southern boundary of Area 1 where the fence is currently located between 250 and 500 feet from the estimated boundary and (2) the current fence is located both inside and outside the estimated boundary of OU-1. As stated in worksheet #10, "*Data gaps and uncertainties that are expected to be addressed by the current DI include:…(7) Boundaries of Area 1 and Area 2 related either to the extent of waste (with regard to the purposes of cap design) or in some cases the extent of RIM*." The statement on page 23 is inconsistent with the rest of the QAPP.

30. **Worksheet #11, Step 4, page 23, last paragraph.** This paragraph states, "*The concern over representativeness can be lessened by increasing sampling frequency; however, subsurface sampling is time consuming and costly, and drilling, particularly in RIM, presents a number of inherent worker health and safety challenges.*" This sentence appears to have been modified in response to the EPA's previous comment 164 b; however, the revision did not include the requested information, i.e., *"further description of the health and safety challenges being referred to in this sentence".* Either provide a full description of the health and safety challenges or delete the rest of the sentence after the word "costly".

31. **Worksheet #11, Step 4, page 25, Sediment.** The last sentence of the first paragraph in this section states, "*Based on this information, the extent of potential Site-derived radiological impacts due to erosion of surficial RIM in Area 1 and from the southeastern portion of Area 2 are topographically constrained to the perimeter drainage ditch conveying runoff to the impoundment, and the North Surface Water Body itself*." Insert the word "*presumed*" before "*topographically*" in this sentence.

32. **Worksheet #11, Table 11-3, Page 27 of 156, PSQ 3.** The cell in the second column for the PSQ-3 row in Table 11-3 states, "*Missouri 10 CSR 80-3 App I groundwater detection monitoring constituents for solid waste plus radiological constituents: Ra-226, Ra-228, U-234, U-235, U-238, Th- 228, Th-230, Th-232*" This description appears to reduce the

full list of groundwater constituents identified in ARARs and as COPCs. Revise the description to be inclusive of all ARARs and ensure groundwater sampling objectives and parameters are sufficient to attain ARARs and meet objectives of the RODA. See comment #25 above.

33. **Worksheet #11, Table 11-3, Page 27 of 156, PSQ 3.** In the third column for the PSQ-3 row in Table 11-3, delete "*Not applicable at this stage".* Groundwater ARARs and all contaminants of potential concern (COPCs) are applicable for monitoring constituents in order to identify which constituents need baseline concentrations established and what potential or future action levels may be. Revise PSQ 3 to ensure groundwater sampling objectives and parameters are sufficient to attain ARARs and meet objectives of the RODA. See comment #25 above regarding PSQ 3 comments.

34. **Worksheet #11, Step 6B: Estimation, page 29 of 156.** Revise the QAAP discussion of the gamma data. The gamma-thorium relationship in Step 6B of PSQ-1 should be parsed out between Step 5 of PSQ-1, and various steps that will be developed for the PSQ related to improving the understanding of the regressions. Discussion of how the regressions will be used in the extent model belongs in Step 5 of PSQ-1, since it relates more to the analytical approach than acceptable precision. Discussion of the regressions themselves belong with the new PSQ. See the general comment on addressing data gaps and uncertainties for specific content that should be included for each step of the DQO process. "*Step 5 of the DQO Process involves developing an analytic approach that will guide how you analyze the study results and draw conclusions from the data*" (EPA QA/G-4), while Step 6 involves specifying performance or acceptance criteria.

35. **Worksheet #11, Step 6B: Estimation, page 29 of 156.** Revised regression analyses, including estimates of detection limits for thorium were presented in Appendix E of the DIWP. The regressions used data truncated above certain activity thresholds. Step 6B of worksheet #11 states, "*The CDF processes developed for the investigation include use of the standard error of the gamma-thorium and gamma-thorium regressions*." Revise the statement as follows: "…*gamma-thorium and gamma-radium regressions*." There are two important caveats to the corrected statement: 1) this is only true if the regression standard errors are not pragmatically adjusted as was done in SSP&A (2017) and 2) this process relies on the assumption of constant variance, which may not be valid even on the log scale. For future modeling efforts, Respondents have proposed using gamma data above a certain threshold for developing regressions. This may be acceptable for limited use, but the estimated relationship should only be applied to count data within the range of the data used to develop the regression model. Applying the relationship developed for a particular range outside that range amounts to extrapolation and is inappropriate.

The threshold above which the gamma-thorium regression can be used should be no less than the gamma count that corresponds to the concentration of radium that can be reliably correlated to thorium (currently around 10 pCi/g). Because this is the gamma count below

which there is no thorium-radium correlation (see the general comment for PSQ-1 for additional discussion), there should theoretically be no gamma-thorium correlation. The data for the regressions should be truncated below a certain gamma count, rather than below a certain activity, since the regressions are used to transform the gamma counts and should be viewed as probable thorium activities given specific gamma counts.

The EPA recommends the data below the "regression threshold" be examined separately and a separate "low count" CDF be developed using a similar process. Since there is no gamma-thorium relationship with the data in lower ranges, the local CDF used in CDF development is not relevant. That is, the local CDF provides no additional information for predicting thorium activities. The starting global CDF is still useful, but the regression cannot be used to inform the indicators, so using the global CDF amounts to pool the data and calculating the proportion of samples with activity above 52.9 pCi/g. This proportion can be used as the indicator input to the extent model. Similarly, this can be done to develop a "low count" radium CDF if the gamma-radium relationship is weak or nonexistent below a certain count. Revise worksheet #11 to address these concerns.

36. **Worksheet #11 – Project/Data Quality Objectives, page 29, Step 6B: Estimation, paragraph 1.** Replace the fifth sentence of this paragraph with "*The gamma measurements support the estimation of RIM through geostatistical methods called indicator kriging at multiple thresholds*."

37. **Worksheet #11 – Project/Data Quality Objectives, page 29, last sentence.** Delete "and PSQ-2" and replace "are" with "is" as the rest of this paragraph and the bullets on the next page appear to be discussing/describing PSQ-1 only.

38. **Worksheet #11 – Project/Data Quality Objectives, page 30, paragraph 1.** Delete the last sentence of this paragraph. Gamma measurements have been proposed for the purposes of locating sampling locations within borings. In addition, the excavation plan will rely in part on gamma measurements.

39. **Worksheet #11 – Project/Data Quality Objectives, page 31, paragraph 1.** The last sentence of this paragraph is unclear to the EPA. Either revise the text to convey the procedures of the process referenced or delete this sentence. See additional comments above for PSQ-3.

40. **Worksheet #12 – Measurement and Performance Criteria, page 43.** In the first three rows of the table on this page that are related to assessment of the radiation detector used in the field, revise the "*Activity to Assess Measurement*" specification to add "*Response check at the end of each day or shift that the instrument is used.*"

41. **Worksheet #17, General Comment.** The EPA acknowledges that the worksheet appears to have been revised in response to the EPA's previous comment 172 to include

additional description of the investigation of the Buffer Zone and Lot 2A2 and the sediment sampling investigation. The EPA has provided significant comments to worksheet #11, including the PSQs that relate to these investigations. Revisions to step 7 - Develop the Detailed Plan for Obtaining Data should be summarized in worksheet #17 so that this worksheet can be consistent with worksheet #11.

The EPA also acknowledges that some evaluations not included with the first draft of the DIWP have been presented in the revised DIWP including in Appendix E. The first 6 paragraphs generally describe the objectives of the design investigation, the relationship to the geostatistical model, and the approach to locating proposed borings. While the DIWP has been revised significantly in response to the EPA's comments on these topics, no substantive revisions were made to these six paragraphs in worksheet 17. In addition, the EPA has provided several additional comments on these topics in the revised DIWP. Therefore, this portion of worksheet 17 must be updated so that it is consistent with the second revision to the DIWP and other comments related to worksheet 11 of the QAPP provided in this letter.

42. **Worksheet #17 – Sampling Design and Rationale, page 64, paragraph 7.** The first sentence of this paragraph states the following regarding PSQ-2, "*…delineating the extent of RIM in the Buffer Zone….*" However, PSQ-2 states, "*Do radionuclide concentrations in the Buffer Zone and Lot 2A2 exceed background?*" Revise the description of the investigation in the Buffer Zone and Lot 2A2 consistent with worksheet #11 and the steps of the DQO process for PSQ-2.

43. **Worksheets #19 and #30 – Sample Containers, Preservation, and Hold Times, page 92.** For analysis for radionuclides in soil, this table specifies collection of two 8-ounce jars. The EPA is concerned that this amount of sample may be insufficient for analysis by gamma spectrometry methods such as GL-RAD-A-013 listed in worksheet # 23. In addition, for Area 1 and 2 samples, where the ratio of radium-226 to thorium-230 is of interest, the laboratory should be instructed to collect subsamples for the radium-226 and thorium-230 analysis from the same sample volume that is dried and homogenized at the laboratory to ensure the subsamples are representative. To facilitate this process, the protocol should be revised to provide the laboratory a single container of sufficient sample volume to perform all requested radiological analyses. Consult with the laboratory and revise the container number, size, and type specification as necessary to meet the laboratory's sample volume requirements and to facilitate the laboratory's subsampling for radium-226 and thorium-230 analysis from the same dried and homogenized volume.

44. **Worksheet #21 – Field SOPs, page 97.** In the fifth row of this table, change "*Ludlum 221 Model 221 or equivalent (2x2 sodium iodide)*" to "*Ludlum 2221 scaler-ratemeter with Ludlum 44-10 gamma detector (2- by 2-inch sodium iodide)*." The EPA understands that a Ludlum 44-10 gamma detector was used during previous investigations to measure

downhole and core gamma activity. For comparability of gamma measurements, the same model of detector should be used.

45. **Worksheet #21 – Field SOPs, page 97.** This table lists Field Sampling Plan Section 2.3.2 (Downhole Gamma Logging) as the Standard Operating Procedure (SOP) for the Ludlum 2221 scaler-ratemeter. This SOP must be revised to address the following:
    a. The appropriate position of the two-position response toggle switch (fast or slow)
    b. The appropriate position of the two-position window toggle switch (in or out)
    c. How to record, in the Boring/Well Construction log, information identifying the instrument (e.g., serial number of the ratemeter and detector).

46. **Worksheet #21 – Field SOPs, page 97.** This table lists Field Sampling Plan Section 2.4.3 (Subsurface Soil Sampling) as the source of the procedure to collect subsurface samples. Revise this SOP to specify that it must:
    a. Include procedures for subsampling the sampled core interval, e.g. specify how will a portion of the core within the selected sampling interval be obtained.
    b. Include procedures for creating field duplicate sample pairs.
    c. Necessitate use of a single sample container for collection of the sample volume to be submitted to the laboratory for radium-226, radium-228, thorium-230, and thorium-232 analysis. The laboratory should be instructed to dry and homogenize the entire sample volume before collecting subsamples for the various analyses.

47. **Worksheet #23 – Analytical Standard Operating Procedures, General Comment.** The EPA previous comment 140 states, "*Laboratory Standard Operating Procedures (SOP) were provided but it is not clear what analytical method is being followed for each analyte.*" The revisions made to worksheet #23 have not provided the needed clarification. Although this worksheet lists the laboratory SOP(s) to be applied to support the investigation, and the FSP lists the analytical parameters for the various samples, the EPA is not able to determine in all cases which laboratory SOP(s) will be associated with a particular sample/analytical parameter combination because some analytical parameters are associated with more than one laboratory. For example, FSP Section 2.4.5.2 identifies radium-226 as an analyte for subsurface soil samples related to Area 1 and Area 2; however, QAPP worksheet #23 lists two laboratory SOPs that could be applied to analysis for radium-226 in solid samples (GL-RAD-A-008 and GL-RAD-A-013). Revise the QAPP and/or FSP as necessary to provide a cross-reference of sample/analytical parameter combinations to their associated laboratory SOP.

48. **Worksheet #23 – Analytical Standard Operating Procedures, page 103.** This table lists EPA Method 901.1, a gamma spectrometry method, as a matrix/analytical group associated with laboratory SOPs GL-RAD-A-008 and GL-RAD-A-009; however, these SOPs specify applications of Lucas cell and gas flow proportional methods, respectively. Revise the "*matrix/analytical group*" entries for GL-RAD-A-008 and GL-RAD-A-009 to correct this discrepancy.

49. **Worksheet# 23 – Analytical Standard Operating Procedures, page 103.** This table lists GL RAD-A-013, a gamma spectrometry method. If this method will be applied to determine radium-226, specify in this worksheet the minimum number of days for in-growth of radium-226 daughters in a sealed container before the sample is counted (Step 11.1.2.1 of GL-RAD-A-013).

50. **Worksheet #36, General Comment.** Worksheet #36 appears to have been revised in response to the EPA's previous comments 175 and 176. However, the revisions are not adequate to address these comments or will require further revisions to other portions of the QAPP. The following provide additional details about these deficiencies. Revise the QAPP to address the deficiencies:

a. The EPA's previous comment 176 required a revision to worksheet #36 "*to clarify what data validation procedures apply to data from radiological analyses.*" In response this comment, the validation procedures included in the table on the worksheet now specify that the validation procedures include the "*QAPP, USEPA National Functional Guidelines for Organic and Inorganic Superfund Data Review dated January 2017, Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual, as amended, and analytical method*". (Underlined for emphasis). The data quality objectives and particular steps 5-7, worksheet #12, and worksheet #34 do not provide information necessary to perform a validation process consistent with the guidance in MARLAP. This is primarily due to the fact that the QAPP has not specified the appropriate Method Quality Objectives (MQOs) and/or is missing site-specific and DQO specific data quality criteria (such as, required method uncertainty, or u_{MR}, and the upper or lower bound of the gray region, or UBGR/LGBR). These criteria need to be determined as described in EPA QA/G-5 and MARLAP and must be listed in the QAPP if data will be validated consistent with the MARLAP guidance. The EPA provided the Respondents a similar comment on the November 12, 2019 Draft Final Remedial Investigation and Feasibility Study Work Plan for OU-3 in a letter dated February 7, 2020. The EPA suggests comment 109 from the February 2020 letter be considered when revising to address this comment.

   The EPA notes however that the QAPP does specify measurement performance criteria for samples being analyzed for radionuclides on page 41 of 156 of worksheet #12 that relate to Minimum Detectable Concentrations (MDCs) which are specified on pages 59, 60, and 63, worksheet #15. While such criteria are not compatible with the data validation guidance in MARLAP, the EPA believes that such criteria could be compatible with the *American Nuclear Society Standard 41.5-2012* (ANSI/ANS 41.5-2012). The EPA also provided Respondents a comment related to the differences between MARLAP and the ANSI/ANS 41.5-2012 in our February 7, 2020 letter regarding OU-3. The EPA also suggests comment 213 from the February 2020 letter be considered when revising to

address this comment. The EPA notes as stated in previous comment 213, "*ANSI/ANS 41.502012 is a prescriptive standard while MARLAP is a multi-agency guidance document and is not prescriptive in nature. ANSI/ANS 41.5-2012 has a precise set of rules and conditions (normally written as shall statements) for the validation and application of validation qualifiers.*" As a result, some additional modifications to the MPCs in worksheet #12 and the definitions of data qualifiers in worksheet #36 would be required to comply with the ANS standard.

Regardless of whether the Respondents choose to follow the MARLAP guidance or implement the ANSI/ANS standard with respect to data validation, the Project Action Limits and Laboratory Specific Detection/Quantitation Limits included in worksheet #15 and the associated MPCs in worksheet #12 must be reevaluated to consider all the revisions to the DQOs in worksheet #11 in response to the other comments provided with this letter.

b. The EPA's previous comment 175 states, "*Worksheet 36 must specify the circumstances under which the data will be rejected as a result of not meeting QC criteria.*" The note that Respondents added to the bottom of the table on page 166 does not provide enough specific information for the EPA to understand the circumstances under which the data will be rejected as a result of not meeting QC criteria. Given the comment provided in "a" above regarding validation of radionuclide data, as well as, additional comments provided for worksheet #11 related to the DQO's, the EPA expects revisions will be needed to the definition of the "R" qualifier and possibly other qualifiers, e.g. if the ANSI/ANI 41.5-2012 standard is adopted. After these other revisions are made, ensure that the definition of the "R" qualifier includes specific language to describe when this qualifier will be applied or that the referenced portions of the QAPP and other guidance documents have such specific information.

EPA comments on the Revised OU-1 Remedial Design Investigation Workplan (DIWP) dated June 5, 2020

51. Section 1.3.1, 1-3

a. **First paragraph after bullets, last sentence**. Previous EPA comment 9.b. was not addressed. Revise the sentence to read, "*This partial excavation of most RIM , in combination with the installation of the engineered cover, will be designed to meet the above RAOs*."

b. **Last paragraph in the section, last sentence**. Delete the last sentence that states, "*Landfill gas management is discussed in Section 11.4 of the Draft 30% Design*.", and provide a discussion here or in the QAPP about sampling needs for landfill gas and radon during the design to ensure that remedial action objective to "control

and treat landfill gas including radon" is fully addressed and accounted for in the Remedial Design. Provide a reference to the document that contains the discussion in the one that does not.

52. Section 2.1, second paragraph, page 2-1.

a. Delete "*as the result of*" from the first sentence in the paragraph.

b. Revise the second sentence of the second paragraph by deleting "*from 0-20 ft B2005GS*" and replacing it with, "*from 0-16 feet and from 0-12 feet B2005GS in accordance with the RODA.*"

c. Revise the third sentence by adding "*at*" between the word's "*activity*" and "*specific*."

53. Section 2.1, last paragraph, first sentence. Page 2-1. Revise this sentence for clarity and grammar.

54. Section 2.2, page 2-2, General Comment. This section must be revised to be consistent with the revisions to the QAPP required by the EPA's comments related to evaluating differential settlement and the depth uncertainty for previously measured intervals of RIM.

a. Second and third bullets of three. A 2005 "*site survey*" or "*ground survey*" was not performed. The 2005 surface is estimated based on interpretation of aerial photographs. Revise for accuracy.

b. Second bullet. Delete "*following the 2005 site survey*", and state when the inert fill material was placed at the site. Third bullet. State specifically where subsidence was observed since 2005 ground survey or delete this bullet.

55. Section 2.2, second paragraph, page 2-2. Historic sample elevations were not based on 2005 ground surface. Revise as necessary.

56. Section 2.2, third paragraph, page 2-2. This paragraph mentions poor soil recovery as a potential source of variability between downhole gamma and for core gamma with hard samples. The EPA agrees with this statement; however, there does not appear to have been an evaluation of areas with poor soil recovery to identify these potential uncertainties. The EPA requests that this uncertainty be evaluated through soil boring logs and incorporated as appropriate into the future regressions and final model when the data collected from this investigation is available.

57. Section 2.2, second of five bullets, page 2-3. Revise the second bullet by describing that comparison of downhole gamma measurements from new borings adjacent to historical borings will allow differential settlement to be evaluated, and potentially corrected for.

The Respondents have proposed two locations in Area 1 that the EPA believes are appropriate for this purpose (A1-SB070 paired with historical boring AC-3, and A1-Th 088 paired with historical boring PVC 38). For Area 2, the EPA proposes the following historic borings be paired with a new boring for this purpose: historical boring PVC-6, historical boring PVC-19, historical boring PVC 10, and historical boring WL-234. These boring locations are proposed in comment 106 below. This information a discussion of how the evaluations will be performed should be added to the appropriate sections in the QAPP, DIWP, and FSP. Also see general QAPP comment 11.c on addressing data gaps and uncertainties.

58. **Section 2.2, third and fourth bullets of five, page 2-3.** Revise these bullets by combining them to discuss drilling methods and core lengths during the DI and delete discussion of the 2005/2019 ground elevation table.

59. **Section 2.2, last paragraph, page 2-3.** Revise this paragraph in consideration of the EPA's comment on the QAPP regarding the data gaps/uncertainties. This paragraph should also describe what will be done when prior borings and hard/soft data are estimated to be above the 2020 ground surface when making these corrections.

60. **Section 3.1. DIOs.**

a. **Section 3.1, item 1, page 3-1.** Combine Design Investigation Objectives (DIOs) 1 and 2 to address SOW 3.6 (a)(1)(iii), Boundary Confirmation OU-1/OU-2. Revise text of DIO #1 to state: "*Delineate the extent of waste and RIM associated with OU-1 Areas 1 and 2 sufficiently to confirm the OU-1/ OU-2 boundaries. This DIO will be addressed through installation of perimeter borings based on the CSM. A combination of field and analytical laboratory methods will be required to achieve this objective*." Also revise other DIO numbers as appropriate.

b. **Section 3.1, item 4, page 3-1**. Revise DIO #4 to read, "*Further characterize RIM between 7.9 pCi/g and 52.9 pCi/g in order to identify the extent of RIM greater than 7.9 pCi/g. for the purposes of confirming the OU-1 boundary and designing and specifying the extent of the UMTRCA cap*."

c. **Section 3.1, item 5 and 6, page 3-1**. Items five and six are already discussed in the QAPP through the data quality objectives for PSQ 2. Revise these DIOs to be consistent with the language in the QAPP.

d. **Section 3.1, item 11 page 3-1.** Revise these DIOs to be consistent with the language in the QAPP.

61. **Section 3.1.1, GSMO #1, page 3-2**.

a. The first sentence of this section indicates that the geostatistical model uses radium and thorium data as measured in laboratory samples or estimated from gamma

radiation measurements. But then the section goes immediately into the potential for variability between core gamma data and downhole gamma data which is not directly related to the correlation between radium, thorium, and gamma but more of a correlation issue with sampling techniques. This section does not mention the fact that gamma cannot be used to detect thorium at the definition of RIM or 7.9 pCi/g. It also does not discuss that thorium at concentrations below 52.9 cannot be estimated reliably from gamma radiation and may be difficult to estimate reliably in some cases below 200 pCi/g. There is a complete lack of discussion of the thorium detection limit and correlation analyses presented in Appendix E and the challenges with the correlation between thorium and gamma and radium and thorium which is why this GSMO is needed. The first and second bullets in this section speak more to how data will be collected for quality control in a SOP, rather than the type and location of data that will be collected and how it will be used to meet this objective. Add discussion to this section to specify what data will be collected and how the data will be used.

b. The third bullet in this section speaks to targeting areas of the regression where data density is low. The paragraph goes on to state that increased data density in the 40,000 to 500,000 counts per minute (CPM) range should be targeted; however; there is no mention of the conclusion drawn in section 4.0 of Appendix E that the relationship between thorium, gamma, and radium needs to be further explored by sampling radium between concentration of 7.9 pCi/g and 52.9 pCi/g. Collection of targeted samples within this concentration range should be added to this GSMO and incorporated into this section, and more importantly, into the boring location and sampling protocol for the DI.

c. The second sentence of the paragraph states, "*The potential for variability between laboratory analytical samples and core scanning data as compared to downhole gamma may be a source of uncertainty within the current model and regressions*." This is accurate, but there is no discussion as to how this potential uncertainty in the historic data is being dealt with. A couple of potential ways to evaluate this uncertainty may be to 1) compare historic downhole gamma logs to core gamma and laboratory samples to identify which borings this may affect so they can be removed from the regressions; or 2) compare regressions developed from new data with regressions developed from historic data to evaluate the degree to which this uncertainty may have affected the existing model or the degree to which historic data can be used. Update the discussion to include how and when this variability will be evaluated or addressed in the data/model.

d. The first sentence below the bullets states, "*The correlation between radium, thorium, and gamma will be improved further through targeted laboratory sample collection….*" The EPA notes that it is unknown whether the correlations will be improved with additional data because that will be based on the data results;

however, additional data where data density is low will improve understanding of the correlations and may improve the regressions. Revise this statement accordingly.

e. Evaluate whether there is a spatial correlation with regards to the distance thorium extends beyond radium at concentrations above the RIM definition. This may be beneficial for locating step out borings or confirmation samples in the future since concentrations of thorium at or near the RIM definition cannot be identified with gamma and the concentration at which thorium can be reliably correlated with radium is still uncertain.

62. Section 3.1.2, GSMO #2, page 3-3.

a. The first sentence of this section states that the current geostatistical model uses historical data sets to determine areas that have a greater than 50% probability of being greater than 52.9 pCi/g; however, it does not discuss the problem the current model has with using gamma data below a reliable detection level and correlation range for predicting thorium at 52.9 pCi/g. This would potentially have the effect of under predicting the 52.9 RIM shell. Revise this section to incorporate these concepts. See QAAP comment on PSQ 1 for more details.

b. IVM gives locations a higher weight if their predicted non-exceedance probability is close to 0.5 and their kriging standard deviation is high, which is similar to the approach suggested by the EPA's previous comment 17; however, the usefulness of the IVM metric as applied is limited and can be improved if the appropriate relationship between these two quantities is accounted for as discussed in the EPA's previous comment 17. Simply multiplying the standard deviation by the square of the probability does not correctly reflect the known relationship between the two quantities in terms of uncertainty around excavation. As introduced in the EPA's previous comment #17, these two quantities have a known relationship given the acceptable decision errors. Using the Case 1 Scenario A error rates as an example, a location with a non-exceedance probability of 0.4 and a standard deviation of 0.11 should carry the same weight to inform sampling as a non-exceedance probability of 0.3 and a standard deviation of 0.22 in order to maintain 35% error rates for both type I and II error. However, they each have IVMs of 0.0176 and 0.000198 respectively, indicating that the non-exceedance probability closer to 0.5 is weighted nearly 100 times more to inform sampling. IVM must be revised or a new metric be developed consistent with the EPA's previous comment 17. While neither the body of the DIWP nor Appendix E provide enough specific information for the EPA to understand how each IVM boring was selected as noted in the tables from appendix G, these borings should be adjusted to ensure borings locations are proposed in consideration of this metric.

Theoretically, it is only beneficial to sample in areas with a high kriging standard deviation and a non-exceedance probability close to 0.5 if those quantities result in unacceptable uncertainty with respect to excavation. Ideally, locations should be considered only if these criteria are met. Therefore, a relative metric is not appropriate here. Locations that meet these criteria (which will tend to have relatively higher kriging standard deviations and probabilities close to 0.5) should then be considered more strongly as potential sampling locations if their non-exceedance probability is further from 0.5. For these locations, not only is there unacceptable uncertainty surrounding excavation, but there is also a greater risk of excavating much more (or much less) volume than is really necessary, compared with those locations with a probability closer to 0.5, where the RIM boundary may be off by one or a few cells. This describes some of the EPA's additional concerns about why the IVM is inadequate. The EPA has provided some recommendations in the paragraphs below pertaining to developing a revised metric.

A metric such as IVM can be used either to select the locations where there is high uncertainty with respect to excavation, or to weight the locations after the model is subset to the 'uncertain' region. For the first case, IVM should have the same value for each pair of probabilities and SDWS for the chosen error rates by taking into account the known relationship between the two quantities. This would allow the three-dimensional space to be subset by that specific IVM value to locate the 'uncertain' region. For the second case, IVM should weight locations with non-exceedance probabilities that are further from 0.5 preferentially higher.

Alternatively, weighting locations with uncertainty that are further from the estimated RIM shell could be accomplished in one step by decreasing the acceptable error rates as the distance from the RIM shell increases. This is alluded to in Table E-3, where the error rates are lower for a non-exceedance probability of 0.7, but the approach is not fully explained. If different error rates are chosen for each non-exceedance probability, this could take into account the preference to sample in locations that are both uncertain with respect to excavation and far from the estimated RIM shell, combining the two steps above into a single step. In this case, we recommend incorporating the error rates into the calculation of the metric used to identify sampling locations. This metric is given as:

$$\frac{KSD_i}{SDWS} = \frac{KSD_i}{0.5 - {x_i}/{z_\beta - z_\alpha}}$$

Where KSD_i is the kriging standard deviation in location i, x_i is the probability of RIM at location i, and z is the z-statistic corresponding to a Type I error rate of α and a Type II error rate of β. The three dimensional model domain could then be subset to the areas with a metric of >1, which is anywhere the kriging standard

deviation is higher than the SDWS, and additional borings could be selected preferentially in this region based on the value of the metric.

63. Section 3.1.3, GSMO #3, page 3-3 to 3-4.

a. The 4th bullet states data will be collected focused on RIM greater than 52.9 pCi/g between 16' and 20'. Revise to reflect that data collection from the 16-20' depth interval should focus on higher concentrations, e.g. greater than 1,000 pCi/g, in order to be relevant for the optimized excavation.

b. 4th paragraph, page 3-4. The first sentence of this paragraph, which begins, "*information related to detecting thorium activities* …" is irrelevant and should be deleted. Any information related to detecting Thorium activities near 52.9 pCi/g via field scanning/logging methods in the draft 30% Design or discussed in meetings that will be used during the DI should be included in this DIWP, the FSP and/or the QAPP.

c. The second sentence after the three bullets states, "*sampling procedures in the FSP are specifically designed to improve the detection limit of thorium*." It's not clear how the detection limit of thorium could be improved if the same survey instrument is used for the gamma survey and the survey is performed using the same procedures as the surveys conducted previously. Provide a citation where this information can be found in the FSP or delete this sentence.

64. Section 3.2 Rim Investigation. This section has little or no discussion of the challenges regarding using gamma data to evaluate thorium and does not appear to have taken the evaluation of thorium and gamma presented in Appendix E into consideration when developing sampling protocol. See general comment 5. Revise this section to discuss and incorporate the analyses performed for Appendix E into the sampling protocols.

65. Section 3.2 Rim Investigation, third paragraph, page 3-4. This paragraph continues to reflect the limited way historical aerial photographs were used to propose perimeter borings, which is not acceptable to the EPA. This paragraph states that site aerials were evaluated during planning to address agency concerns regarding historical site operations in Area 2; however, these aerial photos, in conjunction with the CSM, should be used to evaluate historical landfill activities in the vicinity of OU-1 and OU-2, (not just in Area 2) during the time RIM was brought to the site until the 1977 aerial gamma survey occurred. The text indicates one boring (PB-153) was placed within Area 2 based on historical filling operations seen in aerial photos; however, the previously proposed perimeter borings in the closed demo landfill that appeared to be located based on historical filling activities in a similar timeframe were removed from the revised document. See Enclosure A regarding perimeter boing locations. Revise the text and boring locations to reflect historical filling operations on both sides of the estimated boundary or delete the sentence that states, "*Perimeter borings were placed in areas*

where historical filling operations were observed to supplement historical data collected and better define RIM distribution in these areas."

66. **Section 3.2 Rim Investigation, fourth paragraph, last sentence page 3-5**. This sentence states," *The current model estimations of RIM greater than 52.9 pCi/g are shown on Figure 9A (Area 1) and Figure 9B (Area 2), and were used to identify target depths for field and laboratory sample collection at specific borings*." The second half of this sentence (underlined for emphasis) does not appear to be consistent with other statements regarding sampling depths for this investigation. Revise to clarify which borings this sentence is referring to and what target depths for sample collection were identified or delete the text after the words, "*Figure 9B (Area 2)".*

67. **Section 3.2, page 3-5.** The 3rd paragraph from the bottom of the section proposes borings may be relocated up to 35 feet in Areas 1 and 2. This distance is not consistent with other submitted documents. Revise the relocation distance to 25 (twenty-five) feet which is consistent with Section 2.1.3, page 2-3 of the OU-1 FSP.

68. **Section 3.2.1, page 3-5**. Revise the title of this section consistent with the comment 11.a above on Section 3.1, item 1, page 3-1, which requires DIOs #1 and #2 be combined.

69. **Section 3.2.1, page 3-5 and 3-6.**

a. Revise the 8th paragraph of this section because this approach to deciding whether to perform step outs and selecting sample depths is not adequate based on the limitations of detecting thorium at 7.9 pCi/g. See QAPP comments on this topic which provide further direction on how to develop a step out boring program. Given the limited time frame for the field investigation, it may be prudent to establish an elevated gamma count that would warrant a step out boring rather than waiting for the analytical results from the laboratory.

b. The 10th and 11th paragraphs of this section state, "*each sample will be scanned…*". Replace the word "*sample*" with "*spoon*" or" core" as appropriate.

70. **Section 3.2.2, page 3-7**. The 4th paragraph of the section states that borings were placed to provide coverage in areas where elevated counts were observed outside the currently modeled extent of RIM greater than 52.9 pCi/g. Because the methodology described in the DIWP appears to be comparing the lateral extent of RIM to the lateral extent of the overland gamma surveys, it is not clear if the Respondents were able to identify discrepancies within the predicted RIM shell (for example if the predicted occurrence of RIM is 4 feet below the surface but overland gamma shows RIM at the surface). The EPA agrees that borings have been added to many of these areas; however, there are several areas that the EPA would like to discuss potentially adding or relocating borings to address. Two examples are listed below. In addition, revise the text to clarify whether the modeled RIM shell was compared in three dimensions to the overland gamma survey

in order to identify discrepancies. The text should also specify the criteria or threshold that was used to identify elevated gamma survey results:

- Potentially shift A2-SB-026 northwest to the elevated surface gamma scan
- Potentially add boring between A2-PB127, A2-PB-129 and WL-206 (440pCi/g Th at 0') due to elevated gamma scan area in northeast corner of buffer zone.

71. **Section 3.2.2.1, page 3-7 and 3-8**. Because the radiological contaminants are not in secular equilibrium, thorium concentrations above the definition of RIM are likely to extend beyond concentrations of radium at the RIM definition. The EPA anticipates this relationship to also be true for RIM at the 52.9 pCi/g level. The EPA acknowledges that the Respondents have proposed a grid with closely spaced samples to evaluate areas described as thorium-driven with regards to excavation based on the inability to detect thorium down to 7.9 pCi/g, and Appendix E suggests there may also be some uncertainty surrounding delineating thorium near the 52.9 p/Ci/g level using soft data. The EPA expects the majority of the outer RIM shell to be thorium driven. The EPA agrees with the concept expressed in the second half of the second paragraph regarding using a phased approach to evaluating these so-called thorium driven areas and, even though the work is intended to be completed in one field event, the EPA requests the Respondents develop a prioritization of borings to allow for data results from early field work to help guide field work towards the end of the field period.

72. **Section 3.2.4.2., page 3-11.** According to the National Resource Conservation Service (NRCS) the buffer zone/Lot2A2 is located in the Urban Land (developed/fill) soil complex. This section states, "*An analysis of regional National Resources Conservation Service (NRCS) soil data (Figure 13) indicates that surface soils at each of the proposed background study reference units are similar, generally consisting of silty loam and silty clay, except Reference Area #4 which consists of urban land (developed/fill).*" This summary statement is insufficient. Add additional discussion comparing the listed NRCS soil types. While the EPA does not expect any of the proposed reference areas have been impacted by site contaminates, the proximity of the locations does create some uncertainty. This concern applies to proposed Reference Area #4 which is located close to the property being evaluated. Selection of background reference areas must also be evaluated with respect to potential windblown and water born inputs to the areas. This concern is not related to significant exposure pathways but rather potential impacts to the background distribution of radionuclides. Therefore, the EPA requires that at least one reference area be located a greater distance from the West Lake landfill complex. After review of aerial photos and NRCS data, the EPA proposes that a property located at the Northwest intersection of Earth City Expressway and St. Charles Rock Road, (adjacent to CEVA Logistics) be considered for a potential background reference area. Respondents should evaluate this property and pursue access to collect background samples from the property owner. Also, the EPA is concerned that Reference Area #2 may not be suitable and does not approve this location as a background reference area at this time. Additional information must be provided for Reference areas 1 and 3 to confirm that 1) they have

not been impacted by borrow activities and 2) their location related to bedrock as opposed to alluvium does not create an inherently elevated radionuclides signature.

73. **Section 3.2.4.2.** Page 3-11 states, "*Background samples will be evaluated to determine a statistically significant background activity, which will be used to determine soil remediation objectives associated with soil cleanup in the Buffer Zone and Lot 2A2*." The phrase "*statistically significant background activity*" does not make sense without further details, and it is not clear whether the mean activity or some other statistic is of interest. After verifying use of the background areas for background estimation, the two-sample t-test should not be solely relied upon to compare the background areas and the Buffer Zone/Lot 2A2. Revise this statement as follows, "*Background samples will be evaluated to characterize the distribution of background concentrations and determine the extent to which site concentrations exceed background for the soil remediation objectives associated with soil cleanup in the Buffer Zone and Lot 2A2. This determination will be made based on statistical comparisons which are described in the QAPP*." See the QAAP comment on PSQ-2 for additional details.

74. **Section 3.2.5.1, page 3-12**.

a. In the last sentence of the second paragraph, insert the word "*presumed*" before "*topographically*" in this sentence.
b. In general, the EPA agrees with the sampling approach described in this section but requests that:
    i. an additional sediment sampling location be added between AC-SED-7 and AC-SED-8 towards the south side of the channel to address potential erosion from the landfill slope that required application of the NCC cover.
    ii. in general sediment samples should be collected from between the midline of the drainage to the south bank to account for deposition from both the drainage ditch and potential erosion off the landfill slope, unless otherwise dictated by the bathymetric surface map or other direct evidence of sedimentation. Add this information to the text in this section and the FSP.

75. **Section 3.3, pages 3-15 to 3-17**. Ensure any data collection activities associated with geotechnical and leachate evaluations described in this section are documented adequately in the QAPP and follow the DQO process.

76. **Section 3.3.1, page 3-13**. Due to the unique cover system being proposed for OU-1 to address both landfill gas and radon, propose and implement a landfill gas monitoring program for OU-1 so that site-specific values can be used for modeling purposes. This landfill gas monitoring program must be developed through the DQO process and included in the QAPP.

77. **Section 3.3.3, page 3-14.** The second paragraph of this section states, "*In addition to standpipe wells, borings have been selected adjacent to the previously observed seeps*

and areas of perched water documented during the RI to supplement historical data collected and evaluate liquid levels during the design investigation." Figure 15 includes the standpipe wells, but there do not appear to be additional borings adjacent to the previously observed seeps as discussed in the quote above. The EPA anticipates that data in addition to the standpipe wells may be necessary to evaluate the seep in Area 2 south of the buffer zone in order to ensure this long-standing seep will not negatively impact the future cover. Add the leachate standpipes and any additional borings associated with the seeps to the proposed boring figures and discuss whether additional evaluation will be necessary to resolve this seep in the design.

78. **Section 3.4, page 3-15**. Revise the reference to Appendix F, since there is no longer any additional information included in it.

79. **Section 3.6, page 3-17, first paragraph**. See comments on Section 2.2 of the DIWP and comment 11 on the QAPP related to converting elevation and depth data.

80. **Table 2-1**. The text indicates this table identifies the Design Investigation Objectives (pg. 3-1 or 3- 2) but the table is titled *Geostatistical Modeling Objectives.* Revise the table title to reflect the information in the table. Revise the text to indicate the specific numbers of borings are what is *currently* proposed. The QAPP should include information about how to determine if each objective has been met.

81. **Table 2-2**. **Design Investigation Collection Summary. GSMO 1.** Add another line in the Key Component column for Evaluating Differential Settlement, with a corresponding line in the solution column that discusses comparison of new and historic gamma data from newly paired locations.

82. **DIWP Figures with proposed borings.** Decrease the size of the proposed boring locations on figures to more realistically show borings in relation to each other and site features.

83. **DIWP, Figure 3.** This figure has both Areas 1 and 2 labeled as Area 1. Correct the label.

84. **Appendix E, Table E-1.** Table E-1 has been edited so that the ranges are now equivalent to those given in the PEP, but the empirical variograms still show range lengths of 400 ft for Area 1 (Figure E-2). This discrepancy needs to be explained. In addition, the sills in Table E-1 remain unchanged and are different from those given in the PEP. The radium sill is 0.0072 for Area 1 and 0.03 for Area 2, whereas in the PEP it was 0.08 and 0.04 respectively. The thorium sill is 0.01 for Area 1 and 0.036 for Area 2, whereas in the PEP it was 0.045 and 0.17 respectively. The change in the variograms remains unacknowledged and unexplained. Provide revisions to the appropriate section of Appendix E to explain the discrepancy and the change in variograms. As stated in

comment 12 from the EPA's prior comment letter, additional boring locations would be best informed by using the most current variogram.

85. **Appendix E, Table E-3 and the Figure 11 series.** (a) In Table E-3, it is unclear whether the "RIM 0.5 (-0.1)" and "RIM 0.5 (+0.1)" corresponds to a non-exceedance probability or a probability of RIM. The text states, "The case number of these scenario represent the relationship to of the scenario to 50% non-exceedance probability, Case 1 is "inside" 50% while Case 2 is "outside" 50%" (p. E-17). It is unclear from this explanation what the different cases represent. It should be stated clearly that this column refers to a non-exceedance probability, and that Case 1 refers to inside the RIM shell while Case 2 refers to outside the RIM shell. In addition, the rationale for choosing different error rates for each case, and varying probabilities, should be discussed, along with the conceptual meaning of type I and type II error. Revise the text and table as needed to provide this clarification.

(b) Table E-3 and the Figure 11 series only include 0.4, 0.6, and 0.7 as the non-exceedance probabilities, but ideally samples should be considered for each non-exceedance probability if the kriging standard deviation is high enough. Additional explanation is needed as to why only certain probabilities were chosen, and particularly why 0.3 was omitted. Add this explanation to Appendix E or include updates to table E-3 and an additional Figure 11 series to include the 0.3 non-exceedance probability.

86. **Appendix E, Section 1.2, Page E-3.** Revise items (2) and (3) by specifying the range of gamma counts or radium/thorium concentrations corresponding to each of these items. This will provide clarity to allow the EPA to better understand the distinction between them.

87. **Appendix E, page E-5.** The text states that for the purposes of regression improvement, radium data will be collected in a gamma count range of 40,000 to 500,000 cpm while vs thorium-specific data will be collected in a gamma count range of 40,000 to 300,000 cpm (p. E-5). Because thorium is related to radium, data that improves the radium/gamma regression should also improve the thorium/gamma regression. There is no reason to collect thorium data in a narrower range, particularly since the gamma/thorium regression is so noisy. This appears to be what has been proposed elsewhere in the DIWP and QAPP. Revise the text to clarify that both ranges were estimated but wider range has been selected for the sampling objective.

88. **Appendix E, Section 2.2.2, General Comment.** As part of the sensitivity analysis discussion, include a discussion in Section 2.2.2 which references Figure 6B, describes the purposes of this figure, and the difference in extent between the two CDFs.

89. **Appendix E, Page E-9, General Comment, Grid Cell Size.** The appropriate cell size should be determined by the scale of heterogeneity relevant to excavation that the model

must take into account. The fact that "*estimates of volume and mass increased with increasing density*" suggests that by kriging at larger cell sizes, the model may be missing small pockets of RIM within a cell. If it is feasible to excavate at that scale, the cell size should be decreased. The spatial variation should be examined within the current cell size to determine if the current model resolution is sufficient. If concentrations within a cell vary widely, and it is feasible to excavate only part of the cell, then the cells should be smaller so that RIM can be more efficiently delineated. A simple way to determine cell size is to determine the minimum size that is feasible to account for in the excavation. The model resolution is sufficient for the excavation design when the variation of concentrations within the cell size used are similar to that of concentrations within the minimum cell size.

90. **Appendix E, Page E-9.** It is not clear how the explanation of the volumetric module and specifically the bullets at the end of page E-9 applies to an indicator kriging model, as the "*mass of the analyte*" is not a relevant quantity to the extent model. Revise the text by providing further explanation of this tool, the relationship between mass and volume, and what, if any, parameters must be estimated in order to determine volume. The EPA would expect the IK prediction for each cell could be used to select the number of cells that exceed the probability threshold. Then the number of cells that exceed the probability threshold could be counted and multiplied by the volume of a single cell to estimate the total volume of material that exceed the concentration threshold.

91. **Appendix E, Page E-10.** The text states, "*analyses involving more discretization over a narrower range of values could improve the effects of range length on the volume and extent*". Since it is not possible to "*improve effects*", change this portion of the sentence to "improve understanding of the effects".

92. **Appendix E, Section 3.1, page E-11.** Comment 65b from the EPA's previous comment letter states that the justification regressions developed for the activity model may be acceptable but further justification is needed. The comment also states, "it is not clear why those regressions are not also used for the indicator kriging model. The provide response seems to apply only to part d of comment 65 and related revisions to the text do not appears to be included, thus it is not clear if why two different regressions were developed for the activity and extent models. As stated in the previous comment, "This choice should be further justified, or the same regressions should be used for both models."

93. **Appendix E, page E-12.** The text states, "*often when concentration data change orders of magnitude in short distances, the data distribution can be considered log-normal. Given this data distribution, it is recommended that a log-transform be explored prior to kriging, then kriging the data set, and then back-transforming the data to get estimates of activity*". Before assuming lognormality, a histogram of the data should be checked before and after the transformation to verify that the raw concentrations appear lognormal

and that the transformed concentrations appear approximately normal. Revise the text to describe how the lognormality assumption will be check and include a visual depiction of these checks in future deliverables that provide further analysis of the variograms.

94. **Appendix E, Page E-14.** The text states, "*Identification of areas where the RIM shell geometry is complex, of high concentrations (or high in range), and based on model estimates without previous borings"*. Given the extent model provides predictions for the non-exceedance probability for RIM to be greater than 52.9 pCi/g, it's not clear how areas were identified with "*high concentrations*". The phrase "*or high in range*" is also not clear. Clarify if these areas were identified from activity model which the EPA believes provide predictions of activity concentrations, the output of the SSP&A model at the 1,000 pCi/g threshold, or if "*high probability to exceed the 52.9 pCi/g concentration threshold*" is a more accurate description.

95. **Appendix E, page E-14.** The text states that "*Comparisons of overland gamma to previous and proposed borings to ensure these data are accounted for. Addition borings were added to areas that did not overlap with boring defined above*" in the bullets describing the boring selection process. Revise the bullet by replacing the generic term "*overland gamma*" with "*overland gamma survey results from the original RI*" and replace "*these data*" with "*these areas*". Add the following sentence between the first and second sentence of this bullet, "Because this overland gamma data could not be incorporated into the geostatistical model, there are some discrepancies between the model extent of RIM and areas of elevated result from this survey." Lastly, the second sentence is not clear, and the EPA cannot determine whether borings have been adequately placed to address the discrepancies described above. Consider whether additional revisions are needed consistent with the response to the DIWP comment above on section 3.2.2

96. **Appendix E, page E-14.** The text states that part of the boring selection process was *"comparison of existing and proposed borings (above) with a 2000 m2 grid, if there were any grid cells without a boring an additional boring was added to that grid cell center*". The DIWP must explain the importance of having data density at least at the resolution of confirmation sampling, even if confirmation sampling will not be done using the same grid as was used for boring placement.

97. **Appendix E, page E-18.** The text states, "*n is the total number of nodes in the grid space*" (p. E-18). However, the term "*node*" is unclear in this context as it has not been previously defined. It is not clear if this is equivalent to the number of cells. Define the term "node" and otherwise provide clarification for the statement quoted above.

98. **Appendix E, page E-19.** The text states, "*It appears from Figure E-12 that when radium is between 2.8 and approximately 10 pCi/g the corresponding thorium may be either: less than 52.9 pCi/g (when not correlated to Ra); or correlated to radium when in the range*

of 52.9 – approximately 200 pCi/g." A similar statement was included in the QAPP. This statement does not make sense. Thorium is either correlated to radium in this range or not. Revise this portion of Appendix E to clarify and make sure revised statements that describe the radium-thorium-gamma analyses performed by the Respondents and presented in Appendix E are consistent throughout the DIWP, QAPP, and FSP.

99. **Appendix E, Figure E-2.** Additional description is needed for the nugget/short range variance borings. Justification for the 10-foot distance needs to be provided based on the empirical variograms in Figure E-2 and limitations of spacing in current data for estimating short range variance. Revise the body of the DIWP, Appendix E, and add language to the QAPP to address this proposed data collection.

100. **Appendix E, Section 4.3 and Figure E-12, General Comment.** The analysis presented for justifying a relationship between thorium and gamma counts is not statistically defensible. First, the bulk of the argument is made based on the relationship between combined radium and combined thorium at the Site (Figure E-12), when it should be based on the relationship of interest, between thorium and gamma. The EPA recognizes that the relationship between thorium and gamma exists only to the extent that radium is co-located such that the gamma that radium emits can be detected. However, a statistical analysis needs to be done to demonstrate a clear break point in the thorium/gamma regression itself. The thorium/gamma regression incorporates additional sources of uncertainty and is the endpoint used for prediction within the geostatistical models. The EPA recommends a segmented regression analysis that includes estimation of piecewise regression models and breakpoints (Muggeo 2003). This change point analysis is the appropriate statistical tool for evaluating the gamma count at which the estimated slope becomes relevant. Though the relationship to radium does provide the conceptual basis for correlation between gamma and thorium, the estimated value at which thorium and gamma can be related, as dictated by the data, is a statistical estimation problem and should be approached as such.

The EPA has provided several comments to the QAPP that require changes to proposed sampling protocols which rely solely on gamma surveys to characterize RIM greater than 52.9 pCi/g and in some cases 7.9 pCi/g. These comments generally direct the Respondents to incorporate randomness in the sampling protocol and provide a number of recommendations about how that could be done. Because the thorium-gamma regression will potentially be improved from the data collection proposed for the DI, EPA is not requiring further characterization of the thorium detection limit in the DIWP as long as the sampling protocols are modified consistent with the comments provided in this letter. The EPA does require that the thorium detection limit analysis be completed and presented in the Revised Excavation Plan. The EPA also encourages the Respondents to complete this analysis as soon as possible after the data from the DI is validated since the analysis will inform the needed revisions to the model, and ultimately whether additional data need to be collected in order to meet the design investigation objectives.

101. **Appendix E, Figures E-13 and E-14.** Figures E-13 and E-14 need to show all data, even the low-count truncated data. It is acceptable to show a regression line based on truncated data, but all valid data need to be displayed to allow the reader to assess the selected truncation value. Preferably, a piecewise linear regression line would be displayed, as discussed in Comment 100. Revise these figures to show all the data.

102. **Appendix G, Figure G2**. The proposed perimeter borings on Figure G2 are not the same as those proposed in the figures section of the document. Revise this document to ensure that all proposed boring locations are revised as requested and consistent and accurate.

103. **Appendix G, Figures G1 and G2.** Add Non-Combustible Cover (NCC) surface samples to these figures.

104. **Boring Locations.** The EPA requests boring locations be evaluated and prioritized with regards to potential need or benefits of additional data collection based on early analytical results so that those borings may be installed early in the field program.

105. **Boring Locations**. There are a number of historical borings with hard data that exceed the 52.9 pCi/g for thorium (or radium) that are not included in the 50% probability, 52.9 RIM shell. These locations should be evaluated to determine why the model is not including them. In Area 1 they are: WL-118 with 435 pCi/g Th at 5 feet; WL-114 with 7,868 pCi/g Th at 0 feet (but may be a typo); and 1019S with 63 pCi/g Th at 0 feet. In Area 2 the problematic location is: WL-212 with 117 p/Ci/g Th at 10 feet.

106. **Boring Locations.** In addition to the additional and relocated boring locations required in Enclosure A, there are other areas of OU-1 where the EPA would like to discuss adding or relocating borings with the Respondents. The borings described below are examples of these locations.

Area 1

1) Add Boring 25 feet NW of historical boring WL-118 based on elevated surficial gamma scan and boring data
2) Add Perimeter Boring at Historical perimeter surface sample location 1015S based on surficial Th at 31.17 pCi/g
3) Add Boring halfway between WL-106 and WL-117,
4) Shift proposed Perimeter Boring A1-PB-102 approximately 50’ southeast
5) Boring northeast of historical boring 1D-3S (potentially shift 1A-SB067)

Area 2

6) Add a boring between proposed borings A2-PB-127 and A2-PB-129 where the surficial gamma scan was elevated.
7) Add a boring adjacent to historical boring PVC-10, to evaluate differential settlement and collect hard data.

8) Add a boring adjacent to historical boring PVC 6 to evaluate differential settlement.
9) Add a boring adjacent to historical boring PVC 19 to evaluate differential settlement and collect hard data.
10) Add a boring adjacent to historical boring WL-234 to evaluate differential settlement.
11) Add a boring within the potential isolated pocket associated with historical boring AC-16 to help calculate activities.

EPA comments on the Revised OU-1 Remedial Design Field Sampling Plan (FSP) dated June 5, 2020

107. General Comment. The FSP states that sample locations will be based on elevated alpha, beta, and/or gamma readings in multiple locations on page 2-24. Provide clarity on how, specifically, results from all three readings will be used to determine sample depths if these surveys will still be used to locate samples in the revised FSP.

108. Table 5. The second page of Table 5 in the FSP is incorrectly labelled as Table 3.

EPA comments on the Revised OU-1 Remedial Design Data Management Plan (QAPP)

109. Section 5.4 – Data Types and Procedures. The EPA acknowledges addition of Section 5.4 and other revisions to the DMP regarding calculated parameters in response to the EPA's previous comment #179. It appears that the intent of the revision of the DMP and other documents that address calculated parameters is to provide specifications and procedures for calculating parameters to be used frequently in analysis of the DIWP data (such combined thorium, combined radium, and RIM activity). Although the revised DMP identifies management practices for calculated parameters, it does not convey procedures for calculating the parameters. Revise the DMP and any other related DIWP documents to include procedures for calculation of combined thorium, combined radium, and RIM activity. These procedures should address:

a. Handling of multiple isotope results from a single sample.
b. Handling of missing data (e.g., how will a combined thorium value be defined and/or be usable if the thorium-230 or thorium-232 result is missing).
c. Handling of non-detect results.
d. Propagation of laboratory and data validation qualifiers assigned to the individual isotopic results that comprise the combined result.
e. Definitions of any new qualifiers necessary to convey qualities of or limitations in usability of the calculated parameter, and procedures for assigning such qualifiers to the parameter.

References

Environmental Protection Agency. December 2002. *Guidance for Quality Assurance Project Plans:* EPA QA/G5. https://www.epa.gov/sites/production/files/2015-06/documents/g5-final.pdf

Environmental Protection Agency. February 2006a. *Guidance on Systematic Planning Using the Data Quality Objectives Process:* EPA QA/G4. https://www.epa.gov/sites/production/files/2015-06/documents/g4-final.pdf

Environmental Protection Agency. February 2006b. *Data Quality Assessment: A Reviewer's Guide:* EPA QA/G-9R. https://www.epa.gov/sites/production/files/2015-08/documents/g9r-final.pdf

Environmental Protection Agency. February 2006c. *Data Quality Assessment: Statistical Methods for Practitioners:* EPA QA/G-9S. https://www.epa.gov/sites/production/files/2015-08/documents/g9s-final.pdf

Ramsey, Fred L., and Daniel W. Schafer. 2013. *The statistical sleuth: a course in methods of data analysis.* Boston: Brooks/Cole, Cengage Learning.

S.S. Papadopolous & Associates. 2017. *Estimated Three-Dimensional Extent of Radiologically Impacted Material, West Lake Landfill Operable Unit 1, Bridgeton, Missouri.* December 2017.