COMMENT RESPONSE DOCUMENT: NUREG-1757, VOLUME 2, REVISION 2, CONSOLIDATED DECOMMISSIONING GUIDANCE: CHARACTERIZATION, SURVEY, AND DETERMINATION OF RADIOLOGICAL CRITERIA: DRAFT REPORT FOR COMMENT

NUREG-1757, Volume 2, Working Group

US NRC Rockville, MD

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ABBREVIATIONS

ADAMS	Agencywide Documents Access and Management System
ADR	alternative disposal request
AI	Artificial Intelligence
ALARA	as low as is reasonably achievable
CCM	Contamination Concern Map
cm	centimeter
CFR	*Code of Federal Regulations*
COE	(Army) Corps of Engineers
CRCPD	Conference of Radiation Control Program Directors
CRM	certified reference material
CSM	Conceptual site model
CZ	contaminated zone
D&D	decontamination and decommissioning
DandD	Decontamination and Decommissioning software package
DCF	dose conversion factor
DCGL	derived concentration guideline level
$DCGL_{EMC}$	derived concentration guideline level (elevated measurement comparison)
$DCGL_{W}$	derived concentration guideline level (wide-area [over the entire survey unit])
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DP	decommissioning plan
DQOs	data quality objectives
EMC	elevated measurement comparison
EPA	U.S. Environmental Protection Agency
FEPS	Features, Events, Processes, and exposure Scenarios
FR	*Federal Register*
FSS	Final status survey
FSSR	Final status survey report
ft	foot
FY	fiscal year
GW	groundwater
HDPE	high-density polyethylene
HTD	hard-to-detect
IC	institutional controls
ICRP	International Commission on Radiological Protection
K_d	distribution coefficient
L	liter
LBGR	lower bound of the gray region
LLW	low-level waste
LTP	License termination plan
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols Manual (NUREG-1576)
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment
MARSSIM	Multi-Agency Radiological Survey and Site Investigation Manual (NUREG-1575)
MDA	minimum detectable activity

MDC	minimum detectable concentration
MDC_{scan}	scan minimum detectable concentration
mg	milligram
mil	unit of corrosion (1 mil=0.001 inch)
MIL	modified investigation level
ML	Main Library
MQO	measurement quality objective
mrem	millirem
MRI	Magnetic Resonance Imaging
mSv	millisievert
NAS	National Academy of Sciences
NCRP	National Council on Radiation Protection and Measurements
NEI	Nuclear Energy Institute
NMSS	Office of Nuclear Material Safety and Safeguards (U.S. Nuclear Regulatory Commission)
NRC	U.S. Nuclear Regulatory Commission
NUREG	NRC technical report designation
NYSERDA	New York State Energy Research and Development Authority
OMB	Office of Management and Budget
PA	performance assessment
pCi	picocurie
pCi/g	picocuries per gram
PET	Positron Emission Tomography
pH	hydrogen ion concentration (negative of the log of the hydrogen ion molar concentration)
PMP/PMF	probable maximum precipitation/probable maximum flood
PSR	partial site release
QA	quality assurance
QAPP	quality assurance project plan
QA/QC	quality assurance and quality control
RAI	Request for Additional Information
REMP	Radiological Environmental Monitoring Program
RESRAD	RESidual RADioactive materials (family of computer codes)
Sv	sievert
TEDE	total effective dose equivalent
UBGR	upper bound of the grey region
UMTRCA	Uranium Mill Tailings Radiation Control Act
V_{AD}	value of averted dose

Executive Summary

In December 2020, the U.S. Nuclear Regulatory Commission (NRC) staff published draft NUREG-1757, Vol. 2, Rev. 2, "Consolidated NMSS Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria" for public comment. The staff received 9 comment letters (and 1 request for extension—see Commenter ID 1) from various stakeholders, including States, government agencies, NRC licensees, industry representatives, and members of the public. The commenters and their affiliations are shown in Table ES-1, along with the Accession Number (Main Library [ML] Number) of the comment in the NRC's Agencywide Documents Access and Management System (ADAMS).

ES-1 Table of Comment Letters

Comment ID	Commenter	Affiliation	ADAMS Accession No.
0	Jenny Goodman	State of New Jersey	ML21091A057
1	Bruce Montgomery	NEI	ML21012A003
2	Ram Bhat	Citizen (MARSSIM Working Group)	ML21098A034
3	John Tauxe	Neptune	ML21098A035
4	Riley Carey	US Army Corps of Engineers	ML21104A049
5	Lee Gordon	NYSERDA	ML21104A053
6	Bruce Montgomery	NEI	ML21104A058
7	Karen Tuccillo	CRCPD	ML21104A060
8	Travis Deti	Wyoming Mining Association	ML21104A064
9	Jennifer McCloskey	DOE	ML21104A068

Comments received on the draft document were addressed in the final revision to the report found at ADAMS Accession No. ML22194A859. NRC staff attempted to address comments on subsurface soil investigations in the final document; however, additional guidance will be developed following completion of a contractor report on the topic in 2022. Additionally, comments on discrete radioactive particles will be addressed in interim guidance in the 2022-2023 timeframe. Several opportunities for public interaction on these two topics will be made available as interim guidance is developed.

This document summarizes and bins comments and provides the NRC staff responses to the comments (Table 1). The comments are organized by topical area. Comments are numbered by commenter and then by number of the comment provided by the commenter. Comments are also repeated in Table 2. The formatting in the original comment letter has in some cases been altered to facilitate presentation in Table 2. Please consult the original comment letter listed above in Table ES-1 for additional information about specific comments.

Changes in the final document are oftentimes summarized in the comment response. Text in italics is a quote from the final guidance document. Underlined text in italics is new text that was added to the final document.

Table 1 Comment Summaries and Responses

Subject: 1   - Dose Modeling

Comments: 00-03

Summary: DM01 - A comment was received on the added complexity associated with allowing use of multiple Derived Concentration Guideline Levels (DCGLs), when subsurface residual radioactivity is present, although the commenter recognized the need for derivation of DCGLs for exceptionally deeper subsurface soils. The comment indicated that scenarios should include those that could bring residual radioactivity to the surface through human or natural activities.

Response: The NRC staff agrees that the complexity of the problem increases with the use of multiple DCGLs. However, as the depth or thickness of residual radioactivity increases, the higher the likelihood that the importance of various environmental pathways will change. It is important for the licensee to understand the influence of various factors, including source parameters (e.g., area, depth, and thickness), on dose. See the subsurface soils survey workshop presentations labeled 2-2 and 2-3 by C. Barr and C. Yu for additional information (ADAMS Accession No. ML21208A206). A sensitivity analysis should be conducted to determine key parameters related to dose for surface and subsurface residual radioactivity and data collection should be focused on reducing uncertainty in key parameters as needed to demonstrate compliance with release criteria. A good understanding of the importance of source distribution parameters on dose in particular is important to ensure surveys are optimally designed to limit decision errors. The survey design should be consistent with dose modeling assumptions and dose modeling should account for the vertical and horizontal extent of residual radioactivity. Sections 3.6 and G.7 of Chapter 3 and Appendix G of NUREG-1757, Volume 2, Rev. 2, , respectively, provide additional guidance on dose modeling and survey integration challenges and potential solutions.

As the depth of residual radioactivity increases, the less accessible the residual radioactivity is to workers and other members of the public who could be exposed to the residual radioactivity in the future. Guidance in NUREG-1757, Volume 2, Rev. 2, Appendix J provides information on scenarios that should be considered by licensees for buried or deep subsurface residual radioactivity. Consideration of these scenarios will help ensure that the potential risk of bringing residual radioactivity at depth to the surface from human activity (e.g., basement excavation or well drilling) is considered in developing DCGLs. Natural processes which could bring residual radioactivity to the surface should also be considered (e.g., erosion).

While the licensee always has the option of using the most restrictive DCGL, the DCGLs must consider the total area and thickness of residual radioactivity in soils as well as the cumulative risk associated with all residual radioactivity remaining at the site (i.e.., for all radionuclides and environmental media that contribute to the potential dose to an average member of the critical group).

To address cumulative impacts, some licensees have partitioned the dose limit to consider dose contributions from different environmental media (e.g., 22.5 mrem/yr for soils to account for dose to a potential future resident and 2.5 mrem/yr for sediments to account for dose from potential recreational uses of the nearby land to ensure that the 25 mrem/yr dose limit for unrestricted release found in 10 CFR 20.1402 is not exceeded). See, for example, the West Valley Demonstration Project Decommissioning Plan and associated Technical Evaluation Report (ADAMS Accession Nos. ML090771108 and ML100400099).

For some sites, there is clear separation between surface residual radioactivity (e.g., from spills and leaks on surface soils or due to deposition of radioactivity from accidental air pathway releases) and subsurface residual radioactivity (e.g., from leaks in below-grade structures or components) making it necessary and more practical to develop multiple sets of DCGLs. For other sites, where only soils closer to the surface contain residual radioactivity, the degree of vertical heterogeneity and the magnitude of dose in relation to the dose standard will influence the optimal number of soils layers necessary to demonstrate compliance. Higher risk and more complex sites generally require a more rigorous review to approve DCGLs and the results of the final status surveys (FSSs). The licensee should contact the NRC staff early in the process to improve the efficiency of the review.

Sites with existing groundwater contamination must always consider the risk posed by the groundwater contamination. Therefore, in certain situations, the use of multiple DCGLs or consideration of dose from multiple sources is unavoidable and will be necessary to demonstrate compliance with the license termination rule found in 10 CFR Part 20, Subpart E.

It is important to note that subsurface surveys and derivation of DCGLs are outside the scope of the current version of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and limited guidance is available to address subsurface surveys and dose modeling. Likewise, limited guidance is available with respect to development of derived concentration guidelines levels (elevated measurement comparison) or $DCGL_{EMC}$s for elevated areas or hot spots. The importance of elevated areas may decrease with depth of residual radioactivity. These topics were discussed at the subsurface soils surveys workshop held in July 2021 (see presentations 1-2, 2-4, and 2-5 at ADAMS Accession No. ML21208A206) and are the subject of future guidance to be developed on this topic. Interested stakeholders will be kept abreast of guidance developed in this area prior to the next revision of NUREG-1757, Volume 2.

Text in section 3.6 was revised to indicate that it would always be acceptable to use the most limiting DCGL as follows: *Alternatively, <u>it would always be acceptable to use the most limiting DCGL to simplify the final status survey or</u> dose modeling could be used to confirm that radiological criteria for license termination are met based on the final configuration of residual radioactivity in soils, as measured in FSSs.*

Comments: 00-10

Summary: DM02 - A comment was received to add language to Table 5.1 to state that the screening exposure scenario for residual radioactivity on building surfaces is the building occupancy and the screening exposure scenario for residual radioactivity in the surface and/or subsurface soils is the residential farmer.

Response: The screening scenarios were developed using the Decontamination and Decommissioning (DandD) code for building surfaces and *surface* soils. If *subsurface soils* are present, then the screening values provided in Appendix H of NUREG-1757, Volume 2 cannot be used.

As stated under the *bounding* scenario description, the resident farmer scenario would be appropriate for most site-specific analyses. Text will be added to state that the resident farmer scenario would be a bounding exposure scenario for most sites, including sites with residual radioactivity in subsurface soils.

The bounding exposure scenario description was changed to, *An exposure scenario with a calculated dose that bounds the doses from other likely exposure scenarios. The building occupancy and residential farmer screening exposure scenarios would represent bounding exposure scenarios for most site-specific analyses <u>for residual radioactivity on building surfaces and in surface or subsurface soils, respectively</u>.*

Comments: 00-11

Summary: DM03 - A comment questioned whether construction of a residence on residual radioactivity and associated exposure to the residual radioactivity around and under the residence is considered as part of residential farmer and gardener scenarios.

Response: The default conceptual model in commonly used decommissioning dose modeling codes such as DandD, used to derive the screening values in NUREG-1757, Volume 2, Appendix H, and RESRAD-ONSITE, used to perform site-specific dose modeling discussed in NUREG-1757, Volume 2, Rev. 2, Chapter 5 and Appendix I, assumes a residence is built on top and in the center of the contaminated area.

The word “resident” was added to the text in Section 5.2 to describe the “gardener” to make it clear that the receptor lives on the site.

Comments: 00-12, 06-20, 09-11

Summary: DM04 - Comments were received regarding use of alternative internal dosimetry from Federal Guidance Report No. 11. One comment on Chapter 5 text about age and gender-based dose conversion factors argued that sensitivity, as well as the intake of radioactive material, is important to dose contrary to what is implied in the relevant text. Another comment requested use of dose conversion factors developed and published by Environmental Protection Agency (EPA), National Council on Radiation Protection and Measurements, or International Commission on Radiological Protection (ICRP) for effective dose or total effective dose equivalent (TEDE), while another comment inquired if DOE's Derived Concentration Technical Standard based on ICRP 72 could be used.

Response: The relevant text in Chapter 5, Section 5.2 of NUREG-1757, Volume 2, Rev. 2, clarifies that in the case age-based dose conversion factors (DCFs) are not being used, the same DCFs are applied to all individuals. As such, age-based DCFs are not pertinent to the relevant text. Nonetheless, the parenthetical *(i.e., take in more radioactive material)* was deleted as suggested because the statement is unneeded to make the point. Further down in the paragraph, an example is provided on differences in milk consumption rates for children versus adults which highlights the role of intake rates on dose. The relevant parenthetical *(i.e., take in more radioactive material)* was deleted as suggested in the comment.

As discussed in Appendix I to NUREG-1757, Volume 2, Rev. 2 (see Section I.6.3.6), licensee requests to use more recent dosimetry methods than Federal Guidance Report 11 will be evaluated on a case-by-case basis. For example, licensees may request an exemption from Title 10 of the *Code of Federal Regulations* (10 CFR) Part 20 to use more recent dose conversion factors (e.g., ICRP 72). ICRP 72 provides age-dependent committed effective dose conversion factors for ingestion and inhalation of radioactivity. If a licensee proposes to use ICRP 72, the selection of exposure scenarios and critical groups should take into account differences in potential exposure due to age. Licensees should avoid picking and choosing different dosimetry methods for different radionuclides (e.g., Federal Guidance Report No. 11 for six radionuclides and more current international dose conversion factors such as ICRP 72 for three radionuclides).

Text will be added to Chapter 5, Section 5.2 to address this comment.

The following sentence was added to the text in Chapter 5:

Nonetheless, more recent dosimetry methods could be acceptable for use and will be evaluated on a case-by-case basis (see Appendix I, Section I.6.5 for additional detail).

Comments: 00-13, 00-14, 00-15

Summary: DM05 - A comment was received indicating that groundwater classification restrictions should be considered an institutional control that should be assumed to fail at time=0 years. Because the institutional controls are assumed to fail, members of the public could be impacted by the groundwater pathway, which should be considered in the analyses. Another comment indicated that a licensee could not justify modification or elimination of an exposure scenario or pathway once institutional controls are assumed to fail. Additionally, the commenter went on to indicate that if groundwater could be treated, then the groundwater pathway should not be eliminated.

Response: Section 5.5.2 discusses potential arguments that could be presented by a licensee to help justify elimination of the groundwater pathway. These arguments are not limited to groundwater classification restrictions or restricted release scenarios (i.e., they are also applicable to unrestricted release sites and based on physical or chemical conditions at a decommissioning site). The following examples are excerpted from Section 5.5.2:

- *For example, a licensee may eliminate the use of groundwater because the near surface aquifer has total dissolved solids concentrations that exceed the water quality standards for drinking water and agricultural use.*

- *For example, acceptable justifications for removing the groundwater pathway include the following: (1) the near surface groundwater is neither potable nor allowed to be used for irrigation, (2) the aquifer volume is insufficient to provide the necessary yields, and (3) there are current (and informed consideration of future) land use patterns that would support elimination of the groundwater pathway (e.g., only short-lived radionuclides are present at the site, which is currently located in an industrial section of an urban area with restrictions on groundwater use).*

While arguments based on physical or chemical conditions provide a stronger technical basis, Section 5.5.2 in Chapter 5 of NUREG-1757, Volume 2, Rev. 2, also implies that reasonably foreseeable future land use can also be considered in determining whether potential dose from the groundwater pathway can be eliminated from consideration in the compliance demonstration. Multiple lines of evidence would likely be needed to justify elimination of the groundwater pathway (i.e., local trends and land use restrictions may not be sufficient to eliminate the groundwater pathway from consideration). Furthermore, the licensee would also have to consider less likely but plausible scenarios including changes in local trends and elimination of restrictions on groundwater use.

In making a determination regarding elimination of the groundwater pathway, the NRC staff consults with state and local governments to obtain information on groundwater restrictions, trends, as well as determinations based on groundwater quality, and yield.

Therefore, considerable weight is given to any concerns that affected states, local government (or Native American tribes) provide.

In restricted release cases, Section 5.5.3 indicates that in the case that institutional controls are assumed to no longer be in effect, it may be necessary to evaluate the exposure scenarios and pathways eliminated for the case when institutional controls are assumed to be effective. This passage recognizes that certain scenarios and pathways may be eliminated from the compliance demonstration when institutional controls (ICs) are assumed to be in effect. In the case that the ICs are no longer in effect, the viability of those scenarios and pathways would need to be considered. A higher allowable standard is provided in NRC's regulations for the case that ICs are assumed to no longer be in effect (i.e., 1 to 5 mSv/yr in 10 CFR 20.1403). A parallel can be drawn in the compliance demonstration for unrestricted release sites. While licensees can consider reasonably foreseeable future land use in developing exposure scenarios and in justifying elimination of the groundwater pathway, less likely but plausible scenarios still need to be considered to risk-inform the decision as part of the overall compliance demonstration. For example, if groundwater could be made potable or land use restrictions could reasonably be assumed to fail, then, at a minimum, the groundwater pathway should be considered in less likely but plausible exposure scenarios to inform the decision-making process.

The text was updated to reflect:

1. The need to provide strong justification for elimination of the groundwater pathway based on trends or land use restrictions.

2. The need to consider less likely but plausible exposure scenarios that would include the groundwater pathway, and

3. The need to consult with state and local governments regarding elimination of the groundwater pathway.

The following text was added:

Typically, multiple lines of evidence are needed to eliminate the groundwater pathway, particularly if the justification relies heavily on reasonably foreseeable future land use, trends, or restrictions on groundwater use. Groundwater treatment should be considered in the case that the groundwater pathway is eliminated based on quality. If groundwater use is less likely but plausible, then the pathway should be considered to provide risk information that can be factored into the decision-making process as discussed in Chapter 5.

…

Finally, affected State, local and tribal governments should be consulted when evaluating whether to approve the elimination of the groundwater pathway from the compliance scenario.

Comments: 00-17

Summary: DM07 - A comment was received that the screening values should be adjusted based on the fact that the public dose limit found in 10 CFR 20.1404 includes all man-made sources and that a buffer is needed to consider sources in addition to the residual radioactivity at a decommissioning facility.

Response: The screening values provided in Table B.2., *Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels*, in NUREG-1757, Volume 1 were calculated based on a 25 mrem/yr dose limit (10 CFR 20.1402). Therefore, there should be sufficient safety margin to ensure doses from all man-made sources combined is less than the public dose limit of 1 mSv/yr (100 mrem/yr). As noted in the response to 0-16, rule changes are outside the scope of this NUREG.

No changes were made to the document based on this comment.

Comments: 00-18

Summary: DM08 - A comment was received that a reference was not public: Haaker, R. "Upper Bound for Inhalation Dose from Carbon-14 Vapor and Tritium Vapor," Sandia Letter Report, Sandia National Laboratories, June 1999. (ADAMS Accession No. ML13324B130).

Response: The document has been made publicly available in ADAMS.

No changes were made to this document based on this comment. However, the references were made publicly available as requested by the commenter.

Comments: 03-10

Summary: DM09 - A comment was made on a sentence in Section 1.4.1 that site-specific analyses are more accurate but not necessarily less conservative compared to screening analyses.

Response: NRC staff sponsored development of a probabilistic screening code, DandD, that uses 90th percentile doses from the dose distribution for each radionuclide in developing the screening values, thereby ensuring protection of public health and safety in the case that screening values are used. The DandD screening model used to support the development of screening values for use by decommissioning licensees was, therefore, intentionally designed to err on the side of higher doses with conservative exposure scenarios that maximized the number of pathways (e.g., resident farmer), as well as selection of parameters that led to relatively higher estimated doses for individual radionuclides considering uncertainty in model parameters. Extensive work went into development of the code and parameter distributions as documented in NUREG/CR-5512, Volumes 1, 2, and 3. While NRC staff agree that site-specific dose modeling could lead to higher doses in certain cases, particularly if the underlying assumptions associated with the screening models are not met, the risk that higher doses could be realized with site-specific modeling is expected to be low when the screening model assumptions are satisfied. Nonetheless, the NRC staff agree that the relevant statement is unnecessary in the context it is presented, and the statement will therefore be deleted.

The sentence was deleted from the first paragraph in Section 1.4.1.

Comments: 03-12

Summary: DM10 - One comment was raised that a features, events, and processes (or FEPs) approach, which is typically used for long-term performance assessment for radioactive waste disposal, be invoked as part of the exposure scenario and pathway identification step (2) in the decision framework discussed in Chapter 1 of NUREG-1757, Volume 2.

Response: The Features, Events, Processes (FEPs) process (including exposure scenarios) is widely used to develop conceptual models for the assessment of radiological impacts. Decommissioning sites can range from simple (many sites) to very complex (few sites). While a FEPs process may be of benefit at a complex site, for most sites this formal process would add significant burden without a tangible benefit in the protection of public health and safety. Although a licensee must demonstrate that the scope of its assessment and the scenarios evaluated are sufficient, it can achieve that endpoint through different methods.

No change was made to the document to address this comment.

Comments: 03-14

Summary: DM11 - A comment was raised that the DCGL approach becomes intractable when large numbers of radionuclides are involved.

Response: While the NRC staff acknowledges the potential conservatism of the DCGL approach (e.g., if individual peak radionuclide doses occur at different times), the approach is widely used by NRC licensees and adds value to the decommissioning process. For example, DCGLs can be used to help determine if remediation is necessary prior to conducting the FSS. The DCGL approach is also the central parameter used in MARSSIM statistical tests with MARSSIM being used all over the world to demonstrate compliance with release criteria for decommissioning sites.

Additionally, an alternative approach, the dose modeling approach, is also available as described in Chapters 2, 5, and Appendix I of NUREG-1757, Volume 2. This alternative approach to demonstrating compliance can help alleviate the conservatism associated with the sum of fractions/DCGL approach.

No change is being made to the document to address this comment.

Comments: 03-29

Summary: DM12 - A comment was raised that there is a lack of discussion in the NUREG-1757, Volume 2, Rev. 2, about Ra-226 measurements in covers. The comment went on to state that radium diffusion through a radon barrier in the aqueous phase could occur and lead to production of radon, daughter product of Ra-226, above the radon barrier.

Response: Specific details regarding the modeling of radon and radon precursors through a radon barrier is outside of the scope of this decommissioning NUREG.

No change was made to the document to address this comment.

Comments: 05-01

Summary: DM13 - A comment was made regarding language in Appendix G about building structures and systems and components that may be left in place at license termination. The comment suggested that in addition to dose associated with building structures, systems, or components that residual radioactivity associated with environmental media should be included in the total dose apportionment calculations to determine if the potential dose from offsite use exposure scenarios exceeds a few hundredths of a millisievert.

Response: The NRC staff believes the commenter is referring to the bullet in G.2.1.2 that was added to provide additional guidance on building structures, systems, and components which would be cost prohibitive to remove and/or would lead to excessive worker dose. In general, this section is differentiating between materials and equipment that may remain on the site using provisions found in 10 CFR 20.2002 (see Alternative Disposal Request [ADR] guidance found at ADAMS Accession No. ML19295F109) versus building structures which must meet the 10 CFR Part 20, Subpart E requirements. The difference in the treatment between 10 CFR 20.2002 and 10 CFR Part 20, Subpart E is that under 10 CFR 20.2002 materials and equipment may be more easily removed from the building structures with uncontrolled use of the materials and equipment after the items are released from the site. The NRC staff believes that adding the language proposed by the commenter would go beyond the intended guidance and imply a regulatory requirement more restrictive than found in the regulations.

Furthermore, guidance on consideration of cumulative dose from multiple contaminated media is found in Appendix G to NUREG 1757, Volume 2, Rev. 2, Section G.4 along with suggested approaches for demonstrating that release criteria can be met when multiple sources contribute to the potential doses to members of the public.

No changes are being made to the document to address this comment.

Comments: 05-05

Summary: DM14 - A comment was made requesting the basis for a statement that residual exposure scenarios would not be realistic in an area of active erosion. The comment went on to include examples of where residences are built in actively eroding areas.

Response: The thinking behind the example was that a residence would likely not be built inside a well-defined, actively eroding gully within the flood zone, although NRC staff agrees that, either out of necessity or preference, residences are constructed near or even within actively eroding areas particularly if it is not obvious the site is actively eroding due to the presence of vegetation, the scale of erosion, or the sporadic nature of some erosional processes. Use of more realistic exposure scenarios should be supported by site-specific information. Less likely but plausible exposure scenarios should be considered as part of the compliance decision. Licensees should consider the nature of the erosional processes at a site, including their severity and frequency, along with the availability of more suitable building locations, along with other factors, before eliminating the residential scenario.

The specified text (Appendix I, page I-26) will be deleted from footnote 6 as it is unnecessary and could lead to confusion regarding the types of exposure scenarios that should be considered.

The following phrase in footnote #6 was deleted:

…although the licensee may eliminate a residential scenario, as construction of a residence in the area of active erosion would not be realistic, given its proximity to surface water and uneven topography.

Comments: 06-21, 06-57

Summary: DM15 - A comment was raised that Appendix Q to NUREG 1757, Volume 2, Rev. 2, on uncertainty and sensitivity analysis was not applicable and should not be cross-referenced in other sections of NUREG-1757, Volume 2, Rev. 2 (e.g., Appendix I). Another comment indicated that the appendix seemed to be focused on waste disposal sites with long-term assessment periods and that analysis periods should be limited to 1000 years.

Response: Some of the more complex decommissioning sites with deep subsurface residual radioactivity, existing groundwater contamination, and/or engineered barriers use custom performance assessments (PAs) to estimate potential doses to members of the public. The concepts presented in Appendix Q would be most applicable for these sites with custom PAs. Nonetheless, most of the concepts presented in Appendix Q on technical issues associated with uncertainty analysis would apply to any decommissioning site using probabilistic approaches to demonstrate compliance with license termination rule criteria found in 10 CFR 20, Subpart E. As stated in Chapter 5 and Appendix I, probabilistic approaches can be used to demonstrate compliance with release criteria or to perform sensitivity analysis to provide support for the compliance demonstration. Cross-references to Appendix Q will be retained.

With regard to references to *many thousands of years*, the appendix will be corrected to include the 1000-year compliance period associated with decommissioning. Although the compliance period is 1000 years, longer assessment periods may be conducted for sites with long-lived radionuclides and sites with engineered barriers that may be assumed to perform for hundreds to thousands of years to adequately assess the long-term risk associated with key radionuclides at the site and address the requirements of the environmental assessment.

Section Q.2 was updated as follows:

Reference to the performance assessment analysis period was changed from *many* to: *one thousand to many thousands of years into the future*.

A sentence was added to Section Q.2 to state the following:

Although when calculating TEDE to the average member of the critical group the licensee is required to determine the peak annual TEDE dose expected within the first 1000 years after decommissioning (10 CFR 20.1401(d)), supporting analyses may need to evaluate beyond one thousand years to evaluate temporal sensitivity and uncertainty, especially for sites where risk is driven by long-lived constituents.

Comments: 06-22

Summary: DM16 - A comment was raised requesting additional detail regarding evaluation of heterogeneity in a survey unit and when it would not be appropriate for a licensee to assume homogeneity consistent with dose modeling codes and derivation of clean-up levels or DCGLs.

Response: As a survey unit becomes more heterogeneous, the dose modeling assumptions and basis for the statistical tests start to fall apart (see Table I.7 of NUREG-1757, Volume 2, Rev. 2, Appendix I). Therefore, assessment of the degree of spatial heterogeneity is important to the review. The degree of heterogeneity in residual radioactivity can be assessed through spatial and statistical evaluation of the data, including visualization of the data using geographic information system tools, histograms, box plots, and other approaches. Many of these features are available in the Visual Sample Plan used to design and analyze data obtained from radiological surveys. Additional details on tools and approaches to visualizing the data are provided in NUREG-1757, Volume 2, Rev. 2, Appendix G, Section G.3.1.

If the survey unit contains spotty contamination and/or multiple elevated areas, the dose modeling assumptions related to homogenous contamination may be violated. The risk associated with the elevated areas of residual radioactivity can be assessed through dose modeling or other proposed approaches to ensure the dose from smaller elevated areas of radioactivity is not underestimated. Section I.2.3.1 of NUREG-1757, Volume 2, Rev. 2, Appendix I, contains guidance on how to ensure that elevated area assessments are not overly conservative and more realistically assess the risk associated with multiple elevated areas.

Other methods to mitigate detrimental impacts associated with variability in residual radioactivity include selection of survey units with more homogeneous contamination and use of multiple runs of the dose modeling method (rather than DCGL approach) to estimate the risk associated with the actual distribution of residual radioactivity. Section I.2.3 of Appendix I contains additional guidance on consideration of dose from elevated areas using the dose modeling approach.

The text in Section 5.5.1 was updated to include additional guidance to address this comment:

Evaluation of heterogeneity of soil and building surface residual radioactivity is important because the screening dose modeling code assumes relatively homogeneous sources. Heterogeneity can be assessed through spatial and statistical evaluation of the data, including visualization of the data as described in Section G.3.1 of Appendix G. If heterogeneous sources exist, the risk of elevated areas within the survey unit(s) can be assessed through dose modeling. Other methods to mitigate detrimental impacts associated with variability in source concentrations include selection of survey unit with more homogenous residual radioactivity and dose modeling to assess the risk associated with the actual distribution of residual radioactivity remaining at the site.

Comments: 06-49, 06-50

Summary: DM17 - Comments were made about updated guidance related to support for distribution coefficients or Kds (distribution coefficient) and the potential need for site-specific distribution coefficients if the distribution coefficient is found to be risk-significant. Updated guidance in Rev. 2 is in contrast to guidance in Rev. 1 providing that the use of the more conservative of either the upper or lower quartile of the parameter distribution from the literature was acceptable.

Response: NRC staff determined that use of the upper or lower quartile of the parameter distribution with no additional supporting information is not always technically defensible. The burden is on the licensee to show that the release criteria are met, and the NRC staff require reasonable assurance to make a favorable determination regarding license termination. A statement that the values from the upper or lower quartile are *conservative* for a particular site can only be supported with site-specific information given the large range in values from the literature that can span orders of magnitude for many key radionuclides. Use of generic data sets can lead to risk dilution (e.g., see discussion on use of generic data sets in Appendix Q of this volume along with several supporting references). Furthermore, the data to develop parameter distributions for some radionuclides is sparse, may not be representative of the values at a particular site, and may not be appropriate for use in a dose assessment. In those cases where the K_d for a particular radionuclide is found to be a significant dose driver, then site-specific values should be obtained. The current text does not require experiments and simply states that, if dose and compliance risk are sensitive to the selection of K_d, it may be necessary to conduct experiments using site materials to provide support for K_d values used in dose modeling. Various approaches are available to provide site-specific information to support values selected for a particular site. The recommendations are consistent with the state of science including several publications cited in Section I.6.4.4 of NUREG-1757, Volume 2, Rev. 2 (e.g., EPA, 1999).

No change is being made to the text based on this comment.

Comments: 06-51

Summary: DM18 - A comment was made that other arguments (besides soil quality) may be presented to limit or preclude the plant ingestion pathway and should be considered.

Response: NRC staff agrees that the plant ingestion exposure pathway could be limited or precluded based on many factors including the quality of soil. However, it is more conservative to include the plant ingestion pathway when it is known to be a reasonably foreseeable or plausible exposure pathway. The licensee has the option to exclude the plant ingestion pathway provided an adequate basis for the exclusion of the plant pathways is provided

No changes are being made to the document to address this comment.

Comments: 06-52, 09-42

Summary: DM19 - Comments were made that the large-scale excavation scenario that was added to Appendix J of NUREG-1757, Volume 2, Rev. 2, is not realistic and should be deleted. Comparisons were made to inadvertent intruder scenarios used for low level waste (LLW) disposal facilities. One comment asserted that in the approval of past LTPs, NRC has agreed that this is not a realistic exposure scenario. Another comment suggested that a large-scale excavation was unreasonable because the scenario would represent deliberate rather than inadvertent intrusion given the presence of reinforced concrete structures that was distinguishable from soil. The comment also suggested that large scale projects would be likely to involve characterization and formal permitting activities and therefore would not be inadvertent.

Response: Text in Section J.2.2. of NUREG-1757, Volume 2, Rev. 2 states "[a]rguments could be presented by the licensee why a large excavation scenario is not reasonably foreseeable or why certain pathways are less likely but plausible, or implausible and are simply used to inform decision-making, or do not need to be considered (see Chapter 5 for additional information on compliance, informative, or eliminated exposure scenarios)." Therefore, the NUREG-1757, Volume 2, Rev. 2, is not stipulating that this type of scenario is necessarily expected to be considered reasonably foreseeable for compliance. This type of scenario may be less likely but plausible depending on the location of the site, land-use in the area, and likelihood of large-scale development of the site after the site is released for unrestricted use. Chapter 5 describes that a less likely but plausible scenario is not analyzed for compliance but is used to risk-inform the decision. The comment from Nuclear Energy Institute (NEI) refers to past License Termination Plan (LTP) reviews where the NRC staff had agreed that the scenario was less likely but plausible (but not unrealistic as suggested by the comment). The determination of which scenarios are reasonably foreseeable is site-specific and therefore past reviews may not indicate future review determinations. Also, while a less likely but plausible scenario does not have to be considered as part of the compliance demonstration, it is still used to risk-inform the review as discussed in more detail in NUREG-1757, Volume 2, Rev. 2, Chapter 5, Table 5.1 and associated text.

Furthermore, whether it is considered reasonably foreseeable or less likely but plausible, a large-scale construction scenario would allow for a reasonable occupancy factor and appropriate pathways that would reflect the amount of time an individual would be expected to be exposed to the material. In recognizing the object as a foreign structure, the individual may only be exposed for a long enough time period to move it off site. Also, large structures that have significant excavations are not likely to be used for single family homes and would instead be used for industrial complexes or large apartment buildings. In these circumstances, there would not be significant external exposure and farming would not be expected.

The comment compares the scenarios in NUREG-1757, Volume 2, Rev. 2, to those that were used in the development of 10 CFR Part 61. While several of the intruder scenarios may be similar, the considerations for decommissioning do not necessarily need to match those for low-level waste (LLW) disposal facilities due to the differences in assumed land-use over time. Decommissioned sites that are released for unrestricted use could plausibly be sold to developers who may pursue large-scale construction activities, depending on site location and land-use projections.

The comment indicates that the intruder would recognize reinforced concrete is present and therefore the intrusion would be ‘deliberate’. The NRC staff disagrees with the comment that the intrusion is deliberate. The difference between inadvertent and deliberate intrusion is whether there is knowledge of residual radioactivity present. The scenario outlined in the guidance would classify as an inadvertent intrusion because the individual is assumed to not know that radioactivity is present. The individual would recognize concrete from an industrial closure that needs to be removed before building on the site, but they would still be unaware of the radioactivity being present. For this reason, the scenario is distinct from a low-level waste site where, due to the ownership and closure history, an individual would not reasonably think the site is ‘industrially closed’.

In conclusion, the staff decides to not adopt the recommendation in the comment and will instead retain the discussion of the large-scale excavation scenario for backfilled basements because the guidance allows for arguments to be presented as to why the scenario may not be reasonably foreseeable, and because the scenario is expected to include occupancy factor and pathway assumptions that assume the intruder recognizes the material as foreign.

No changes are being made to the document to address this comment.

Comments: 08-02

Summary: DM20 - A comment provided an example of modeling buried radioactivity (backfilled excavation) using RESRAD, which is pertinent to examples provided in NUREG-1757, Volume 2, Rev. 2, Appendix J, including consideration of the radium benchmark dose as stipulated in 10 CFR 40, Appendix A, Criterion 6.

Response: While NRC staff appreciates the comment and example, radium benchmark dose calculations conducted to meet regulations in 40 CFR 190 and 10 CFR Part 40 are conceptually different than license termination rule criteria found in 10 CFR Part 20, Subpart E (e.g., the license termination rule uses a dose based standard and not a concentration-based benchmark calculation).

Therefore, to avoid confusion, the example will not be added to the final guidance document. While examples of dose modeling associated with buried residual radioactivity (including inadvertent intrusion) are appreciated, specific examples *are not* typically provided in guidance, while lessons learned from review of decommissioning and license termination plans and radiological surveys *are* reflected in guidance.

No changes are being made to the document based on this comment.

Comments: 09-06

Summary: DM21 - A comment was made that verbiage in contract documents requiring site-specific data (e.g., site- specific exposure scenarios, exposure pathways, parameters, critical groups, selection of conceptual and mathematical models, and codes) be included in NUREG-1757, Volume 2, Rev. 2.

Response: The NRC staff agrees that for site-specific analysis, detailed information about site-specific exposure scenarios, pathways, mathematical/conceptual models, and key parameters is needed. The NUREG-1757, Volume 2 lists the types of information that should be included in a decommissioning or license termination plan to support the decommissioning process. NUREG-1757, Volume 2, presents guidance on acceptable approaches to demonstrating compliance and does not constitute a requirement.

Since each site is unique and each review is considered on a case-by-case basis, NUREG-1757, Volume 2, Rev. 2, includes examples of the types of information that the NRC staff would expect to be included in the submittal. NUREG-1757, Volume 2, Rev. 2, includes guidance to the licensee on methods to provide adequate support for its compliance demonstration, but does not include details on the source of the technical information. Therefore, specific language regarding contractual requirements in the NUREG-1757, Volume 2, Rev. 2, appears to be inappropriate.

No change to the document is proposed to address this comment.

Comments: 09-07

Summary: DM22 - A comment was made in support of a 1000-year compliance period for decommissioning.

Response: NRC staff agree with the observation in the comment. A 1,000 year compliance period is consistent with NRC regulations and guidance.

No change is being made to the document to address this comment.

Comments: 09-13

Summary: DM23 - A question was raised about the need for and distance from a decommissioning facility for which a licensee would need to consider off-site exposures.

Response: The NRC staff would expect offsite exposure scenarios to be evaluated if an offsite group could be considered a critical group. A critical group means a group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances. Additionally, evaluation of an offsite exposure scenario could help risk-inform the decision. As stated in NUREG-1757, Volume 2, Rev. 2, Section 3.3, *Insignificant Radionuclides and Exposure Pathways*, detailed modeling is unnecessary for doses less than 10 percent of the dose limit (i.e., 0.025 mSv/yr for unrestricted release), which may assist licensees in determining when offsite exposures start to become insignificant or negligible.

No change is being made to the document to address this comment.

Comments: 09-14

Summary: DM24 - A question was raised regarding the 30,000 mg/L value used in an example for dissolved solids content to eliminate the use of groundwater for drinking water or irrigation due to groundwater quality.

Response: The 30,000 mg/L value used in the draft report was provided as an example value to support the discussion for why a licensee may eliminate the groundwater pathway associated with the resident farmer exposure scenario but still need to consider related exposure pathways associated with the scenario. (This specific example was also provided in the previous version [Rev. 1] of NUREG-1757, Vol. 2). It was not intended to be used as a regulatory limit for which decisions are based.

To avoid possible confusion regarding the use of 30,000 mg/L as a regulatory value, the NRC staff has modified the text in the NUREG to the following:

For example, a licensee may eliminate the use of groundwater <u>from consideration if</u> the near surface aquifer has total dissolved solids <u>concentrations that exceed the water quality standards for drinking water and agricultural use</u>.

Comments: 09-15, 09-44

Summary: DM25 - Comments were raised about the depth of soil which should be considered surface residual radioactivity.

Response: The definition of surface soil is copied and pasted from the glossary in NUREG-1757, Volume 2, Rev. 2, below to provide context for the comment response.

Surface Soil. The top layer of soil on a site that supports certain exposure pathways such as direct exposure, soil ingestion, and resuspension of particles for inhalation. Surface soil has also been associated with the thickness of soil that can be measured using direct measurement or scanning techniques. Typically, this layer is often represented as the top 15 centimeters (6 inches) of soil but will vary depending on the radionuclide, surface characteristics, measurement technique, and dose modeling assumptions.

While surface soils are approximately the top 15 cm of soil, surface soils could be more or less than 15 cm. The licensee needs to consider the detection capabilities of the instrument and exposure modeling assumptions to perform a reasonable survey. For example, DandD provides a screening methodology for surface soils and assumes sufficient area and thickness are available to support certain pathways.

Many considerations go into the definition of surface soil as described above, including the ability to detect the radionuclides of interest. The term is used generally, and as stated in the definition, the thickness can be larger or smaller for a particular site. The reference to 30 cm was changed to 15-30 centimeters recognizing that the exact thickness of surface soil is not fixed.

The bullets were changed as follows:

- *surface soil (less than 15-30 centimeters [cm] (1 foot [ft])?*
- *deep soil (greater than 15-30 cm [1 ft])?*

Comments: 09-19, 09-22

Summary: DM26 - Comments were made that the default expression for retardation factor in the release version of RESRAD-OFFSITE and -ONSITE are the same, noting that a section describing benchmarking with an earlier version of RESRAD-OFFSITE noted differences in travel times due to differences in use of porosity in the transport calculations.

Response: The guidance indicates that the RESRAD-OFFSITE code used in the benchmarking with RESRAD-ONSITE used an earlier version of the code prior to the 2007 release of RESRAD-OFFSITE 2.0. An additional sentence will be added to the end of the paragraph to note that the current version of RESRAD-OFFSITE uses the same default expression for the retardation factor. However, the retardation factor expression used in the prototype version of RESRAD-OFFSITE is available as a user selectable option in the current version of RESRAD-OFFSITE.

The following sentence was added to the pertinent paragraph in Section F.10.2, Appendix F, of NUREG-1757, Volume 2, Rev. 2:

The current versions of RESRAD-ONSITE (7.2) and RESRAD-OFFSITE (4.0) use the same retardation factor expressions by default, although the option in the prototype version of RESRAD-OFFSITE is still available as a user-selectable option in RESRAD-OFFSITE version 4.0. Context specific help on "retardation factor" in RESRAD-OFFSITE indicates that the key command ALT-F will bring up an option to change the retardation factor expression on the "groundwater transport" screen. Section H.2.1 of NUREG/CR-7268 Vol. 1 (RESRAD-OFFSITE 4.0 User's Manual) provides additional information about options for the retardation factor expression.

The following sentence in F.10.2 was edited as follows:

Because the prototype version of RESRAD-OFFSITE is the only code to consider immobile pore water in the calculation of the retardation factor…

The following sentence was added to the end of the paragraph:

As stated above, it is important to note that the current version of RESRAD-OFFSITE (4.0) uses the same default value for the retardation expressions as RESRAD-ONSITE (7.2). The option to use the same retardation factor expression in the prototype version of RESRAD-OFFSITE is still available as a user-selectable option in RESRAD-OFFSITE 4.0.

Comments: 09-20

Summary: DM27 - A comment noted differences in results observed for water-dependent pathways due to differences in the accumulation of radioactivity in the soil from application of irrigation water in RESRAD-ONSITE versus RESRAD-OFFSITE.

Response: The guidance will be updated to note the differences in accumulation periods between RESRAD-ONSITE and RESRAD-OFFSITE.

The following sentence in Section F.10.2, Appendix F, of NUREG-1757, Volume 2, Rev. 2, was revised to address the comment as follows:

Another noteworthy difference in results was observed for the water-dependent pathways due to differences in accumulation periods of radioactivity in soil from application of contaminated irrigation water that is considered in RESRAD-OFFSITE over multiple years but is only considered over a single growing season in RESRAD-ONSITE.

Comments: 09-27, 09-31

Summary: DM28 - Questions and comments were raised about the lack of consideration of C-14 and H-3 dose from the vapor phase (DandD only considers inhalation dose from the particulates) and the inapplicability or need for update of the screening values published in Appendix H.

Response: Although the inhalation dose from C-14 and H-3 from gases or vapors is not considered in DandD, insignificant adjustments to the screening values would be needed because the inhalation dose is a small fraction of the dose from these two radionuclides after adjustments are made to the inhalation dose based on the Haaker reference cited in Appendix I to NUREG-1757, Volume 2, Rev. 2. However, if changes in exposure scenarios or parameters in a site-specific analysis causes the inhalation dose to be more significant, then Figure I.5 can be used to adjust the inhalation dose.

In response to the comment, the text in Section I.4.3, Appendix I, NUREG-1757, Volume 2, Rev. 2, was changed to state the following:

As an example, DandD considers only the inhalation dose from particulates in the air and does not consider the loss of H 3 and C 14 from the soil to the air as a gas or vapor. To adjust results from the DandD resident farmer exposure scenario for analyzing sites that contain either H 3 or C 14 (Haaker, "Upper bound for inhalation dose from carbon-14 vapor and tritium vapor," published June 1999) (Haaker, 1999), (1) determine the area of the contaminated zone, (2) run DandD for the site with only H 3 or C 14, (3) read the associated activity ratio factor for the given area from Figure I.5, and (4) estimate the potential missed dose by multiplying the inhalation dose calculated from DandD by the activity ratio factor to account for the dose associated with the gas or vapor phase. Due to low risk-significance of the inhalation pathway dose for the resident farmer scenario used to derive the screening values, no change was made to the published screening values in Table H.2 to address the missed dose for C-14 and H-3.

Comments: 09-29

Summary: DM29 - A comment was made that RESRAD-ONSITE has the option for users to use a flag "-1" in the input field for the contaminated fraction for plant food that scales the contaminated plant fraction by the contaminated area, as well as an option to specify the contaminated fraction of produce between 0 and 1. RESRAD-OFFSITE does not constrain the agricultural field to be on top of the contaminated area and therefore, the flag is not an option available in RESRAD-OFFSITE.

Response: Changes were made to footnote 5 to clarify contaminated fractions between 0 and 1 can also be input to the model. Reference to RESRAD-OFFSITE was deleted from the footnote.

RESRAD-OFFSITE was deleted from the footnote in Section I.2.3.2, Appendix I, NUREG-1757, Volume 2, Rev. 2, and the following sentence was added to the footnote:

Contaminated fraction values between 0 and 1 can otherwise be specified as a user input.

Comments: 09-30

Summary: DM30 - A comment was made regarding less conservative methods for considering elevated areas that may be approved on a case-by-case basis.

Response: An alternative to the approach laid out in the examples and text associated with Figures I.1 and I.2, Section I.2.3.2, Appendix I, NUREG-1757, Volume 2, Rev. 2, is to model the actual distribution of residual radioactivity at the site. Tools in Spatial Analysis and Decision Assistance (computer code) can be used to evaluate variability in exposure area concentrations based on a spatially moving average concentrations for different size exposure areas to assess the risk associated with elevated areas. The guidance also discusses potential elimination of exposure pathways and modification of exposure parameters based on the size of the elevated area in Section I.2.3.2, Appendix I, NUREG-1757, Volume 2, Rev. 2. Licensees should work with the NRC staff early in the process to help it determine the best approach in addressing elevated areas for a particular site.

No change is being made to the document to address this comment.

Comments: 09-36

Summary: DM31 - A comment was made to add "ingrowth and decay of short-lived radon progeny during transport in air are modeled" to Section I.5.3.6, Appendix I, NUREG-1757, Volume 2, Rev. 2, describing removal processes in the RESRAD-OFFSITE air model.

Response: The sentence was added as requested by the commenter.

Added the following sentence to Section I.5.3.6, Appendix I, NUREG-1757, Volume 2, Rev. 2 :

Ingrowth and decay of short-lived radon progeny during transport in air are simulated.

Comments: 09-37

Summary: DM32 - A comment was made to delete reference to NUREG/CR-7267, Tables 6-1 and 6-3, because the tables do not list default behavioral and metabolic parameters as stated in the sentence in Section I.6.2.3, Appendix I, NUREG-1757, Volume 2, Rev. 2.

Response: The NRC staff agrees with this comment. The reference to Tables 6-1 and 6-3 in Section I.6.2.3, Appendix I, NUREG-1757, Volume 2, Rev. 2, will be deleted.

Comments: 09-38

Summary: DM33 - A comment was made requesting correction of a statement to the ingestion rates available in RESRAD-BUILD. Both a direct and indirect ingestion rate are included in RESRAD-BUILD.

Response: The NRC staff will correct the table to indicate that RESRAD-BUILD has two ingestion rates: an (i) indirect and (ii) direct ingestion rate. The table and footnote will be updated to reflect this information and point to additional reference material.

Table I.11 was updated to include the RESRAD-BUILD indirect and direct ingestion rates and default parameter values. The footnote that indicates there is only one ingestion rate in RESRAD-BUILD was updated as follows:

The default loose fraction in DandD is 0.1 and is multiplied by the default loose ingestion rate 1.1x10-04 to get an effective ingestion rate of 1.1x10-05 m^2/hr (0.1 x 1.1x10-04 m^2/hr=1.1x10-05 m^2/hr). See NUREG/CR-7267 and ANL/EAD/03-1 for additional information about the RESRAD-BUILD ingestion rates.

Comments: 09-45

Summary: DM34 - A comment was made that a pond may also get contamination from soil erosion, water runoff, and direct deposition and that omitting the aquatic exposure simply based on groundwater availability at a reasonable depth, while not considering these other mechanisms for contamination of the pond, may not be appropriate.

Response: The current text is reflective of the conceptual model implemented in DandD, which does not consider the types of environmental transport pathways referred to in the comment. However, the commenter is correct that in certain situations, these pathways could be important. Accordingly, the text was revised to include these pathways if they could lead to significant potential dose to a member of the public.

The text in Section M.2.2.2, Appendix M, NUREG-1757, Volume 2, Rev. 2, was revised as follows:

If significant contamination of surface water could occur from other processes such as sediment delivery to surface water from soil erosion due to surface water runoff and/or deposition of airborne radioactivity, then more sophisticated models such as those available in RESRAD-OFFSITE that consider these environmental transport pathways may need to be considered (see RESRAD-OFFSITE User's Manual [NRC, 2020a; NRC, 2020b] for additional detail). If the surface water pathway contributes less than 10 *percent of the dose standard, then detailed modeling of the additional environmental transport pathways does not need to be considered (see Section 3.3 of this volume for additional information on insignificant radionuclides and exposure pathways).*

…

The aquatic pathway can be removed from the resident farmer exposure scenario if it can be shown that all groundwater, surficial (runoff and erosion), and airborne pathways cannot lead to significant contamination of the surface water body.

Subject: 2 - Radiological Surveys

Comments: 00-04

Summary: RS01 - A comment was received regarding the need for adding the words "vertical and horizontal" before the word "extent" with respect to radiological characterizations.

Response: The NRC staff agrees with the suggestion. The words *horizontal and vertical* were added to clarify the word *extent* in Chapter 4.

The words *horizontal and vertical* were added prior to the word *extent* in multiple locations in Chapter 4.

Comments: 00-07, 00-08

Summary: RS02 - A comment was received regarding the need for additional information as part of the FSS including information on measurement errors, minimum detectable concentrations (MDCs), and information to demonstration that MARSSIM, Rev. 1, Equation 8-2 is satisfied and that elevated areas are not so numerous in the survey unit that the dose criterion is exceeded.

Response: The NRC staff generally agrees with the commenter's recommendations. Text was added to the bullets regarding the need for information on MDCs, and text was added to note that summaries of field or laboratory reports providing information on measurement error or uncertainty would be helpful to NRC staff's review. MARSSIM, Rev. 2, and NUREG-1757, Volume 2, working groups will also continue to work to address preliminary comments from the Environmental Protection Agency's Science Advisory Board and State of New Jersey's comments on NUREG-1757, Volume 2 with respect to consideration of measurement quality objectives (MQO) and consideration of measurement uncertainty. Any updated NRC guidance in this area will be communicated to interested stakeholders prior to the next revision to this volume. No italics were added to the text as NRC staff did not see the need to emphasize certain information needs over others.

With regard to the portion of the comment about using Equation 8-2, and the need to consider the number of elevated areas in demonstrating that the dose criterion is not exceeded, NRC staff would note that Equation 8-2 presents one acceptable method to address elevated areas, but that other options are available. The text was also revised to indicate that Equation 8-2 or some other alternative method should be used to demonstrate compliance with release criteria.

The text in Section 4.5.1.1.3, Chapter 4, NUREG-1757, Volume 2, Rev. 2, was revised as follows:

- *The measured sample concentrations, in units that are comparable to the DCGLs<u>, and associated minimum detectable concentrations (MDCs); summaries of laboratory or field measurement reports could be included to provide useful information on measurement error and uncertainty</u>.*

- *A statement that a given survey unit satisfies the $DCGL_w$ and that elevated areas above the $DCGL_w$ were considered in demonstrating compliance with release criteria (e.g., using MARSSIM, Rev. 1, Equation 8-2 or other approved method), as applicable.*

A footnote was also added regarding the need to consider the cumulative dose associated with multiple radionuclides and media. MARSSIM, Rev. 1, Equation 8-2 or an alternative approach could be used to assess cumulative dose and demonstrate compliance with release criteria. It is important to note that NRC staff would accept other approaches to demonstrating compliance with release criteria, particularly when multiple elevated areas are present due to the conservatism associated with MARSSIM, Rev. 1, Equation 8-2, particularly if the external dose pathway dominates the dose as discussed in more detail in Section I.2.3.1, Appendix I, NUREG-1757, Volume 2, Rev. 2. Draft MARSSIM, Rev. 2, also discusses technical issues associated with Equation 8-2 and indicates that the operator should work with the cognizant regulatory authority to discuss acceptable methods for addressing elevated areas.

The following footnote was added to the bullet about consideration of elevated areas: *It is important to note that all radionuclides and sources that could cumulatively contribute to dose to the average member of the critical group should be considered in assessing whether release criteria are met. If multiple contaminated media or elevated areas could cumulatively contribute to dose, then MARSSIM, Rev. 1, Equation 8-2 or another approved method could be used to demonstrate compliance.*

Comments: 00-09

Summary: RS03 - A comment was received about checking measurement results from laboratory data sheets against data reported in the FSS reports (FSSRs) as part of the Detailed Technical Review.

Response: The NRC staff added the recommended check as an example as requested by the commenter.

Section 4.5.1.2.2, Chapter 4, NUREG-1757, Volume 2, Rev. 2, was updated to state the following: *The detailed review could include confirming the selection process and location of measurements using survey unit maps or floor plans, checking measurement results from laboratory data sheets with those inserted into tables or figures in the FSSR, using parameters that are specific to the survey methodology, and re-creating the appropriate MARSSIM statistical test results.*

Comments: 02-02

Summary: RS04 - A suggestion was made to link to YouTube videos to explain statistical terms, and to request Kahn Academy videos on any statistical concepts for which no video exists.

Response: Typically, NRC staff does not include links to web sites in its documents because there is no guarantee that the web sites will be maintained over time. However, the NRC staff thinks the comment provides good suggestions. The staff will work with the MARSSIM working group to evaluate potential training opportunities including evaluating the benefit of developing videos or listing resources for key statistical concepts used in MARSSIM.

No change was made to the document to address this comment.

Comments: 02-05

Summary: RS05 - A comment was received about the potential for artificial intelligence to be extended to decommissioning to increase the accuracy and efficiency of decommissioning of nuclear power reactors, for example.

Response: Machine learning to optimize various aspects of decommissioning, including radiological surveys and dose modeling, appears to have potential but requires additional research. Under contract with SC&A, the NRC staff is evaluating various techniques for analysis of subsurface data to assist with survey design and demonstration of compliance with release criteria. While no changes are planned for this revision of the guidance document, the NRC staff will provide interim guidance or otherwise communicate initiatives and developments in this area as they are developed.

No changes are being made to the document to address this comment.

Comments: 03-11

Summary: RS06 - One comment indicated that the decision framework should be similar to the data quality objectives (DQOs) process and begin with identifying the question that needs to be answered rather than amassing a great deal of data and constructing a model.

Response: The DQO approach, in Section 3.2, Chapter 3, NUREG-1757, Volume 2, Rev. 2, is intended to be more of a survey planning process which can be incorporated into an overall assessment of site termination options such as those presented in Section 1.4.2, Chapter 1, NUREG-1757, Volume 2, Rev. 2. However, staff acknowledge that relatively simple sites may be able to satisfy the requirements, in total, using just the DQO approach. Having both discussed allows the licensee the option as to which one (or both) applies to their situation. Staff also note that the last bullet number (13) was inadvertently omitted from the steps in Section 1.4.2, Chapter 1, NUREG-1757, Volume 2, Rev. 2, creating confusion.

The number 13 was added to the last bullet beginning *in certain limited circumstances, terminating the license may not be feasible*...

Comments: 05-04

Summary: RS07 - A comment was made that the streambed sediments be included in the discussion in Section G.7, "Integration of Dose Modeling and Radiological Surveys", and also points out the lack of guidance in MARSSIM.

Response: Draft MARSSIM, Rev. 2, does contain some discussion regarding sampling surface water and streambed sediments in Section 5.2.2.2, Chapter 5, NUREG-1757, Volume 2, Rev. 2, *Conducting Surveys*. However, the sampling of surface water and streambed sediments poses unique challenges.

Section G.4, Appendix G, NUREG-1757, Volume 2, Rev. 2, contains information on *Surveys Associated with Multiple Radionuclides and Media* and includes an example where residual radioactivity is present in streambed sediments. Although the general approach to development of DCGLs including consideration of exposure scenarios and applicable pathways is found in Appendix I of NUREG-1757, Volume 2, Rev. 2, and applies to streambed sediments, it is less clear if specific examples and tools are available to facilitate development of DCGLs for streambed sediments. NRC staff will consider development of additional guidance and tools in this area in the future.

No changes are being made to the document to address this comment. NRC staff will consider the need for more specific guidance and tools to address streambed sediments in the future.

Comments: 06-04, 06-15, 06-19

Summary: RS08 - Comments indicated that resolution of issues with hot particles, excavation surveys/assessments, and use of in-situ gamma spectrometry is needed to avoid multiple requests for additional information and lengthy reviews. The comment went on to state that the resolution of these issues is needed prior to finalizing the guidance. Another comment indicated its support of NRC staff intent to hold a workshop on guidance document topics indicating that a workshop could help provide a more complete understanding of the many changes to the voluminous document, to facilitate discussion on how NRC will resolve comments, and allow additional comments to be made.

Response: The NRC staff plans to address the issues of surveying for discrete radioactive particles and considerations for the use of in-situ gamma spectrometry to address excavations in separate guidance documents or in a future revision to this guidance. Staff do not plan to defer this issue indefinitely to the future, but instead are actively planning to begin this guidance in a reasonable timeframe. However, the staff do not want to unreasonably delay the publication of this revised version to include these issues. The issue of excavation surveys/assessments is discussed in Section 3.6, Chapter 3 and Appendix G of this guidance. Workshops are planned for 2022 as interim guidance is drafted for dose modeling and surveys associated with subsurface residual radioactivity and discrete radioactive particles.

No changes are being made to the document to address this comment.

Comments: 06-03

Summary: RS09 - A comment was raised that there is a disconnect between the minimum information NRC expects to receive in a license termination plan, FSS plan, and related reports and the types of information the NRC instructs reviewers to examine. The comment goes on to state that the revision seems to point to significantly more data than has been deemed necessary by NRC in the past. A risk-informed license termination process with clear alignment on necessary level of detail for license termination plans, final status and related reports is sought.

Response: The NRC staff thinks that the amount of information that the NUREG calls for licensees to submit is commensurate with the NRC's needs to review licensee submittals. Without specific examples of areas that the guidance calls for licensees to submit unnecessary data or additional information beyond what is needed to make a determination regarding license termination, the NRC staff is unable to address this comment. NRC staff will continue to work with its stakeholders to improve its guidance and address technical issues of concern.

No changes are being made to the document to address this comment.

Comments: 06-07

Summary: RS10 - A comment was received to provide alternative approaches for calculating ratios of insignificant to significant radionuclides.

Response: The text will be revised to emphasize that determination of ratios is an area that will be reviewed by NRC staff and that certain alternative approaches will be considered on a case-by-case basis depending on the site characterization data.

The text in Section 3.3, Chapter 3, NUREG-1757, Volume 2, Rev. 2, was updated to state the following: *Ratios should be conservatively selected so that they do not underestimate the potential dose contributions of the insignificant radionuclides. <u>For example, using the minimum detectable concentrations (MDCs) or actual reported concentrations (even when less than MDCs), consistent with MARLAP principles, may be appropriate except in cases where > 40% of results are less than the MDC.</u> Use of the 95th percentile ratios of insignificant to significant radionuclides <u>is acceptable and</u>*

alternative approaches will be considered on a case-by-case basis depending on the site characterization data.

Comments: 06-08

Summary: RS11 - A comment was received to delete a parenthetical limiting the applicability of side-by-side surveys to partial site release.

Response: NRC staff agrees with removing the parenthetical in Section 4.1.2, Chapter 4, NUREG-1757, Volume 2, Rev. 2, as it could potentially limit a reader's understanding of situations in which side-by-side surveys are more efficient.

The parenthetical, …*(with subsequent PSRs)*[1]… was removed.

Comments: 06-10

Summary: RS12 - A comment was made requesting that the word "shall" be changed to "should" regarding the performance of a scoping survey.

Response: Because NUREG-1757, Volume 2, Revision 2, is guidance and provides acceptable methods to meet NRC regulations, the guidance is not mandatory. The comment recommendation to replace *shall* with *should* was made.

Changed *shall* to *should* in Section 4.2.1, Chapter 4, NUREG-1757, Volume 2, Rev. 2, as follows:

Therefore, the licensee should perform a scoping survey typically consisting of limited direct measurements (exposure rates and surface activity levels) and samples…

Comments: 06-11

Summary: RS13 - A suggestion was made to add the words "At a minimum, the FSSR should contain the information outlined in (Section) 4.5.1.1.3".

Response: The NRC staff agrees with addition of the suggested words to the sentence.

The sentence recommended in the comment was added:

At a minimum, the FSSR should contain the information listed in 4.5.1.1.3.

[1] PSR - Partial Site Release.

Comments: 06-12

Summary: RS14 - A suggestion was made to change the word "may need to" to "should" in the following sentence: "the NRC reviewer may need to obtain previous NRC-generated reports on the FSS, including but not necessarily limited to inspections, confirmatory surveys, and any safety evaluation reports that may have addressed the FSS plan…"

Response: The recommended change was made to Section 4.5.1.2, Chapter 4, NUREG-1757, Volume 2, Rev. 2.

Section 4.5.1.2, Chapter 4, NUREG-1757, Volume 2, Rev. 2, text was changed to the following:

In addition, the NRC reviewer should obtain previous NRC-generated reports on the FSS, including but not necessarily limited to inspections, confirmatory surveys, and any safety evaluation reports that may have addressed the FSS plan.

Comments: 06-13

Summary: RS15 - A comment was received that the long listing of factors and examples that may trigger a more detailed review is contrary to the objective of a risk-informed approach.

Response: The text in Section 4.5.1.2.3, Chapter 4, NUREG-1757, Volume 2, Rev. 2, preceding the list of factors indicates that these factors be considered for potential review (does not mandate a review). The text goes on to state that the reviewer should focus on survey units for which there are risk-significant issues, prevalent across a larger number of survey units instead of isolated cases. Furthermore, the list includes specific examples within broader categories to provide detailed guidance to reviewers on the types of characteristics that may warrant a review. Detailed examples are preferred to help reduce reviewer subjectivity. Although it makes the list look longer, NRC staff believes that the more detailed guidance is helpful to reviewers.

The list of examples was reviewed and found to be reasonable. The last bullet will be changed to *the use of non-routine sampling methods* instead of calling out *composite sampling* in particular because guidance in new Appendix O provides information on acceptable methods to use composite sampling for a survey design.

A statement was added that the reviewer does not have to review every instance of a potential issue particularly if the same issue is identified in multiple survey units, and that a representative survey unit or survey units can be selected for review.

The following sentence was added to Section 4.5.1.2.3, Chapter 4, NUREG-1757, Volume 2, Rev. 2:

Reviewers do not have to review every instance of a potential issue, particularly if the same issue is identified in multiple survey units. A representative survey unit or survey units can be selected for review.

The last bullet of Section 4.5.1.2.3, Chapter 4, NUREG-1757, Volume 2, Rev. 2, was changed to the following:

The use of non-standard sampling methods to establish compliance with release criteria (i.e., DCGLs).

Comments: 06-16

Summary: RS16 - A comment was received that the rationale for why a detailed review may be needed in some cases was unclear.

Response: The bullets under *Detailed Review Topics* are suggested considerations for detailed technical review of survey units. Note that the list is not exhaustive and not all of these areas are applicable to all survey units that would merit detailed technical review. The text in the three bullets was clarified so the technical concerns that would trigger a detailed review are clear.

The following bullets in Section 4.5.1.2.4, Chapter 4, NUREG-1757, Volume 2, Rev. 2, *Detailed Review Topics*, were edited as follows:

- *If the MDC values are high, does the licensee's analysis rely on a large number of results expressed at MDC (minimum detectable concentration) or MDC values (which may invalidate assumptions)?*

- *Plot or visualize the data on a location map and ask: is there a discernible trend in the results within or and among survey units? Survey units should be fairly homogeneous, and this type of visualization can aid in identifying if elevated areas may have been split across survey units when they were delineated.*

- *Are there any assumptions about the variability (variance) of the population? For example, if the estimate of variance is inappropriate, then the survey design could be negatively impacted (e.g., low power or inadequate number of samples).*

Comments: 06-17

Summary: RS17 - A comment requested that the guidance provide additional detail on acceptable approaches for identifying and justifying the removal of outliers, or that discussion about outliers be removed from the guidance document.

Response: Removal of sample data with high concentrations or detections as outliers could lead to an underestimate of dose or could lead to misclassification of a survey unit if the data points removed are, in fact, valid. Several tools are available for identification of outliers. For example, visualization of the data and use of control charts or box plots can be useful tools to identify outliers.

Use of investigation levels consistent with MARSSIM, Rev. 1, Table 5.8, should lead to identification of elevated areas, although there are situations that may warrant case specific evaluation and resolution (e.g., Scenario B evaluations). In general, outliers should be considered as part of the data set collected in a survey and addressed by the licensee unless the data is found to be invalid. Reanalysis of samples and/or review of laboratory quality assurance and quality control (QA/QC) results should inform decisions regarding the validity of the data. The licensee and/or the laboratory should have protocols and criteria (see guidance in Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP, NUREG-1576), MARSSIM, Regulatory Guide 4.15, American National Standards Institute N42.23-2003, etc.) for determining if data are valid and usable.

The acceptance or rejection of an outlier should be made during the data validation and verification using a process established before the survey occurs (e.g., quality assurance project plan (QAPP), approved survey procedure), and the approach for handling outliers should consider the statistical tests being used to assess the data. To determine the significance of removal of data, the statistical test could be run with and without the *outlier(s)* to determine the sensitivity of the result to removal of potential outliers.

The text in Section 4.5.1.2.4, Chapter 4, NUREG-1757, Volume 2, Rev. 2, was updated as follows:

- *Were any outliers identified through box plots, control charts, or other acceptable method? In general, outliers should be considered as part of the data set when evaluating compliance unless the data is found to be invalid (e.g., through reanalysis and/or review of laboratory QA/QC results). If outliers were removed from the data set when evaluating compliance, appropriate technical basis should be provided for removal of the outliers consistent with a data validation and verification process established before the survey occurred (e.g., quality assurance program plan or QAPP)?*

Comment: 06-18

Summary: RS18 - A comment was made that guidance should be added indicating which analytical tools would be acceptable for use without a detailed review.

Response: The section discussed is simply directing staff to ensure that the analytical tools used by the licensee were appropriate and used correctly. Because there are many software options available, including use of custom spreadsheets, staff do not believe that designating a specific software as being *acceptable* is appropriate in this instance.

No changes are being made to the document to address this comment.

Comments: 06-24

Summary: RS19 - A comment was made that much of the information in Appendix A is redundant with MARSSIM and is unneeded.

Response: NUREG-1757 is meant to be a consolidation of guidance. As such, staff think it appropriate to include redundancy with MARSSIM to some extent. Because MARSSIM is a multi-agency document, in some cases NRC staff include additional clarifications or approaches that may not be fully developed in MARSSIM. Likewise, additional details on surveys not provided in NUREG-1757, Volume 2, can be obtained directly from the MARSSIM guidance document.

No changes are being made to the document to address this comment.

Comments: 06-25

Summary: RS20 - A comment was made that requested that power reactor licensees be afforded a simple approach for clearing relatively clean areas of the site, including use of screening values and reuse of materials on-site (e.g., fill for excavations).

Response: Appendix B methods could be used for unimpacted or Class 3 areas at reactor sites with appropriate documentation and supporting information. The Alternative Simplified Method in Appendix B.3 indicates that 100 percent scanning and 30 samples could be used by default. In general, unimpacted areas, assuming they remain unimpacted throughout decommissioning activities, would not require an FSS. Class 3 areas would not require 100 percent scanning and the number of samples would be dependent on how close the average concentration in the survey unit is to the DCGL (i.e., Class 3 areas are expected to have a larger width of the grey region and relatively fewer samples compared to Class 1 areas, for example). Therefore, the Appendix B requirements may actually be more burdensome compared to the current FSS methods for unimpacted and Class 3 areas.

Regarding the reuse of soil, unimpacted soil that remains unimpacted throughout decommissioning activities on site can be reused for backfill with appropriate supporting documentation. If there is a concern that the soil is impacted or may have become impacted due to decommissioning activities, Section G.3.2.2, Appendix G, NUREG-1757, Vol. 2, Rev. 2, indicates that a Scenario B approach can be used to demonstrate that soil is free of residual radioactivity or “indistinguishable from background” to allow reuse of the soil. The costs associated with showing that the material is free of residual radioactivity may be greater than showing that the soil is below screening levels or a site-specific DCGL, however. If slightly contaminated soil is used as back-fill the dose associated with reuse of slightly contaminated fill materials should be considered in demonstrating compliance with release criteria.

Should the licensee intend to reuse concrete from demolished structures onsite, the expectation is that, prior to demolition, the materials will be surveyed using methods that meet the statistical rigor and quality of MARSSIM. Given that Appendix H screening values are for building surfaces and a building occupancy scenario, and not for rubblized concrete planned for reuse as backfill, dose modeling reflective of the planned reuse of the slightly contaminated demolished concrete material in its final configuration onsite would require prior NRC approval.

Because multiple media (soil, groundwater, and structures) may contain residual radioactivity at complex sites, it would likely be necessary to preliminarily characterize the various media in order to assess appropriate fractioning of the contribution to hypothetical dose from each media and that same fractioning would then be applied to any screening criteria proposed for a “simplified” method. Because that could be a rather significant and time-consuming effort, NRC staff believes most licensees would not desire that approach. Regardless, licensees may propose an approach that they feel works for their respective site. Guidance in Appendix G of NUREG-1757, Volume 2, Rev. 2, indicates that any materials being reused on site must be surveyed to the rigor of a FSS appropriate for the area in which they originated. However, temporary storage of unimpacted soils or concrete demolition material may result in contamination of the material itself due to other decommissioning activities, and therefore resurvey of the material prior to reuse as backfill may be necessary. Furthermore, temporary storage of such materials pending reuse has the potential to spread contamination to the area used for storage and those areas must be surveyed upon final disposition of stored materials, even if already surveyed.

No changes are being made to the document to address this comment.

Comments: 06-29

Summary: RS21 - A comment was made requesting that specific language be included in Appendix D that points to MARLAP Appendix C QC acceptance criteria for comparisons of: (i) on-site analytical results to off-site analytical results, (ii) on-site split or duplicate samples to standard samples, and (iii) replicate static measurements to standard static measurements.

Response: The text in Section D.3.1, Appendix D, NUREG-1757, Volume 2, Rev. 2, *The Planning Phase,* will be updated to include specific reference to MARLAP Appendix C as well as RG 4.15, Section 6, *Quality Control in Radioanalytical Laboratory*, which cites Chapter 18 of MARLAP as providing *guidance on monitoring key laboratory performance indicators to determine whether a laboratory’s measurement processes are in control*. MARLAP, Chapter 18, describes a numerical performance indicator for the analysis of a certified reference material (CRM) in Equation 18.5. The MARLAP, Chapter 18, protocol could be used for split samples sent to two different labs.

The following text was added to Section D.3.1, Appendix D, NUREG-1757, Volume 2, Rev. 2:

<u>MARLAP Appendix C contains information on quality control (QC) acceptance criteria for comparisons of (1) on-site analytical results to off-site analytical results, (2) on-site split or duplicate samples to standard samples, and (3) replicate static measurements to standard static measurements. Furthermore, RG 4.15, Section 6, “Quality Control in Radioanalytical Laboratory,” which cites Chapter 18 of MARLAP as providing “guidance</u>

on monitoring key laboratory performance indicators to determine whether a laboratory's measurement processes are in control." MARLAP Chapter 18 describes a numerical performance indicator for the analysis of a CRM in Equation 18.5. Also, the MARLAP Chapter 18 protocol could be used for split samples sent to two different labs.

Comments: 06-53

Summary: RS22 - A comment was made that a section in Appendix J needs additional information on the level of survey needed to assess contamination on building basement concrete.

Response: Section J contains guidance on conceptual models which may be used to estimate DCGLs for buried materials or backfilled basements and does not address survey methods. Considerations for surveys of concrete surfaces (such as basement surfaces) may be found in Appendix A and G of NUREG-1757, Vol 2, and in NUREG-1507, Rev. 1.

No changes are being made to the document to address this comment.

Comments: 07-01

Summary: RS23 - A comment was made to define the word "should" in Appendix A.

Response: As noted in Section 1.2, Chapter 1, NUREG-1757, Volume 2, Rev. 2, *Roadmap to this Volume*, this NUREG provides guidance; the processes and methodologies described in the document are not requirements. Section 1.2 also notes that licensees and the NRC staff should interact early in the process regarding developing a decommissioning plan (DP) specific to their site and the criteria that the NRC staff will use to evaluate the information submitted by the licensee to support decommissioning.

No changes are being made to the document to address this comment.

Comments: 09-17

Summary: RS24 - A comment was raised requesting a more objective universal protocol for radiological surveys noting excerpts from current guidance describing scan surveys and detection of residual radioactivity based on surveyor performance.

Response: There is not a universal protocol that may be applied to ensure scans are more objective. The quality of scans may be impacted by several factors including the surveyor's experience level, and other human factors. Defining an appropriate scan investigation level will contribute to the objectivity of scan evaluation. The NRC staff recommends review of Chapter 6 of NUREG-1507 for additional information on human factors and a priori MDC scan calculations.

No change is being made to the document to address this comment.

Subject: 3 - Statistical Tests

Comments: 04-01

Summary: ST01 - A comment was raised regarding the use of Scenario B for a case where the lower boundary of the grey region is zero or background and a background discrimination level is used for the upper boundary of the grey region rather than a clean-up level of DCGL.

Response: NRC staff did not intend to limit applicability of Scenario B to the indistinguishable from background case discussed in NUREG-1505, Chapter 13, although this is the primary application and example provided in Appendix G. Scenario B simply means that the null hypothesis is that the survey unit meets the release criteria. Likewise, NRC staff did not intend to establish values for the lower bound of the gray region (LBGR) (or action level) and upper bound of the gray region (UBGR) (or discrimination level). However, NRC staff did provide examples on how to calculate such parameters for the indistinguishable from background case in order to enhance practical application of the method. The terminology used in MARSSIM, Rev. 2, draft for public comment is consistent with the usage in NUREG-1757, Volume 2, Rev. 2, and NRC staff coordinated with the MARSSIM working group on the revisions.

The text will be clarified to point out that the LBGR of the gray region could be zero added radioactivity and that the UBGR could be some background discrimination level, or other acceptable method proposed by the licensee.

Table 2-1 was updated to add a footnote to the Scenario B, null hypothesis entry:

The concentration of residual radioactivity in the survey unit is indistinguishable from background[1]…

[1] *While in most cases Scenario B is expected to be used to show indistinguishability from background, a more general use of Scenario B is to show that the survey unit meets the release criteria. Therefore, other applications for Scenario B are available and may be found acceptable provided sufficient technical justification is provided.*

The following text was added to Section G.6, Appendix G, NUREG-1757, Volume 2, Rev. 2:

MARSSIM also points to a situation where the release criteria are based on no added radioactivity above background and/or the radionuclide is not present in background. This results in an action level of zero added radioactivity and makes the selection of the LBGR in Scenario A difficult, if not impossible to select.

…

Scenario B simply denotes the null hypothesis is defined as the survey unit meeting the release criteria. Therefore, other applications of Scenario B are available and may be found acceptable provided sufficient technical justification is provided. For example, MARSAME and MARSSIM, Rev. 2, discuss a scenario where the LBGR is set to zero (or zero added radioactivity above background) and the UBGR is set to some background discrimination level.

Comments: 09-03, 09-04

Summary: ST02 - Comments were made to clarify what the implementation of Scenario B is with respect to the FSS statistical test Scenario B.

Response: The following words were added to clarify what Scenario B is in the *Abstract* and Table 2 of the *Forward*:

an alternative for the null hypothesis of statistical tests evaluated in a final status survey.

Comments: 09-10

Summary: ST03 - A comment requested clarification of Type I and II errors.

Response: The following text was added to Section 4.5.1.2.4, Chapter 4, NUREG-1757, Volume 2, Rev. 2, after Type I error: *(false positive—incorrectly rejecting the null hypothesis when it is true)* and after Type II error: *(false negative—incorrectly retaining the null hypothesis when it is false)…*

Subject: 4 - Sampling Design

Comments: 04-02

Summary: SD01 - A comment was raised regarding the purpose of composite sampling to maximize sample representativeness and to get a better estimate of the mean, rather than to focus on detection purposes or to better understand sample variance.

Response: The approach laid out in Appendix O follows the MARSSIM paradigm which consists of discrete sampling to provide an estimate of the median or mean in a survey unit and scan surveys with sufficient detection capability to identify elevated areas of concern between discrete sampling points. Consistent with the MARSSIM methodology, composite sampling can be used with the formal MARSSIM statistical tests with a modified investigation level (MIL) approach to ensure that potential elevated areas could be identified such that the risk of elevated areas is not underestimated. The NRC staff recognizes that other approaches are available that could be found to be acceptable with sufficient technical justification.

MARSSIM, Rev. 2, and NUREG-1757, Volume 2, Rev. 2, note potential conservatisms associated with use of Equation 8- 2 in MARSSIM, Rev. 1. Alternative methods have been proposed to reduce the conservatism of the estimated risk associated with elevated areas in Appendix I of draft NUREG-1757, Volume 2, Revision 2 (e.g., Section I.2.3). For example, dose modeling assumptions including assumptions regarding applicable pathways, parameters, and exposure scenarios could be modified to provide a more realistic estimate of the risk from elevated areas. Higher $DCGL_{EMC}$s would lead to higher MILs and relief associated with potential re-sampling of increments to identify potential elevated areas.

With regard to consideration of heterogeneity, an underlying assumption in most dose modeling codes is that the radioactivity is not overly heterogenous (or is relatively homogenous). Evaluating the risk of smaller areas of elevated activity helps mitigate the risk of underestimating the potential dose associated with these smaller areas and is consistent with MARSSIM methodology. The NRC staff agrees that composite sampling could also be useful in determining a better estimate of the mean in elevated areas. Text will be added to this effect.

While composite sampling tends to reduce variability, the critical level is based on the number of samples. With fewer composite samples analyzed (compared to discrete analysis of individual increments), the critical level is adjusted accordingly to obtain results similar to discrete sampling at the desired alpha error (or false positive error). Scoping simulations conducted by NRC and Oak Ridge Institute for Science and Education staff show that composite sampling is just as protective as discrete sampling at the desired false positive rate for the Sign Test and Scenario A for the cases tested (e.g., normal and lognormal distributions with a known mean). Although no significant negative effects on power were observed for the vast majority of cases, the impact on power for other distributions, statistical tests and scenarios, including Scenario B, could be studied through simulation to support use of composite sampling in other cases. The power to reject the null hypothesis is particularly important for Scenario B to ensure that a site with residual radioactivity which will exceed the dose limit is not released. NRC staff recommends working with the regulator early in the process to determine the efficacy of composite sampling for a particular survey design.

The context of Appendix O is for sampling strategies for a FSS as well as site investigations such as characterization surveys. The advantages numbered 1, 2 and 4 are applicable to an FSS, and advantages listed in Table O.1 are applicable to other survey types such as characterization. Detection of a radionuclide of concern (e.g., estimating the presence or absence of a specific radionuclide) is one of several applications of composite sampling discussed in Appendix O, but it is not the only use of composite sampling.

NUREG-1757, Volume 2, Revision 2, presents acceptable approaches to demonstrating compliance with the release criteria. The licensee can propose alternative methods to demonstrating release criteria are met. Composite sampling could be an important component of alternative proposed methods.

A bullet was added to Section O.3.1, Appendix O, NUREG-1757, Volume 2, Rev. 2, as follows:

- *Composite sampling can be used to provide an estimate of the mean concentration in an identified elevated area*.

Comments: 04-03

Summary: SD02 - A comment was made that if the purpose of composite sampling was to get more representative samples to estimate the mean concentration, has NRC considered method uncertainty requirements as the preliminary MQO rather than the detection objective captured through use of a MIL as described in Appendix O.

Response: As stated in response to comment 4-2, composite sampling has been considered for the purpose of increasing sample density, although the impact of the decrease in sample variability should be considered as part of the planning and design process. Although Multi-Agency Radiation Survey and Assessment of Materials and Equipment (MARSAME) and MARLAP include the concept of quantification capability, MARSSIM takes a different approach by incorporating requirements for quantification capability into detection capability with the requirement that the MDC be less than the UBGR and by recommending that the MDC be less than 50 percent of the UBGR (See Chapter 6). Chapter 6 also discusses instruments and survey techniques for scans and direct measurements, and Chapter 7 provides information on sampling and laboratory analysis. Appendix H describes typical field and laboratory equipment, plus associated cost and instrument capabilities.

Regarding use of composite sampling and MQOs, NRC staff recommends that the survey planning team develop MQOs for each project-specific objective in view of proposed measurement methods used for the survey. In turn, the proposed measurement method should be evaluated against the MQOs to determine whether the MQOs can be met, taking into consideration the use of composite sampling. It is expected that the uncertainty in a laboratory measurement (e.g., the total propagated uncertainty) would not change if composite sampling methods were used to collect samples in the field. However, if there is a source of error in sample collection due to use of composite sampling, it should be addressed during survey planning.

As stated in response to comment 4-2, the proposed composite sampling methodology could provide better estimates of the mean to answer the question of whether the mean activity over a discrete area is within some specified limit. However, following the MARSSIM paradigm, the purpose of the FSS is also to determine the potential dose contributions of elevated areas within the larger survey unit. To satisfy this secondary objective, the purpose of the MIL is to determine if residual radioactivity is potentially present above the $DCGL_{EMC}$ in an elevated area. As also stated in response to comment 4-2, composite sampling could be used to provide a better estimate of the mean for the area of elevation to ensure that the risk of the elevated area is appropriately considered. Furthermore, methods are available to reduce the conservatism of the $DCGL_{EMC}$ as described in Appendix I (e.g., Section I.2.3) of NUREG-1757, Volume 2, Revision 2. Text will be added with regard to the potential use of composite sampling to better estimate the mean of the elevated area.

A bullet was added to Section O.3.1.1, Appendix O, NUREG-1757, Volume 2, Rev. 2, *Uses of Composite Sampling*, to indicate that composite sampling could be used to estimate the mean of the elevated area as follows:

- *Composite sampling can be used to provide an estimate of the mean concentration in an identified elevated area*.

Comments: 06-26

Summary: SD03 - A comment was made indicating that much of Appendix C is academic and may not be needed.

Response: While the material in Appendix C is technical and may not apply to most decommissioning projects, it does contain useful information on the assessment of survey data when double or two-stage sampling is used.

No changes are being made to the document to address this comment.

Comments: 06-27, 06-28

Summary: SD04 - A comments was made to define all of the terms in Equation C-1 and Table C.1.

Response: The commenter is referred to Section 10.2, NUREG-1505, *A Proposed Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys–Interim Draft Report for Comment and Use*, issued June 1998, where this equation is discussed in more detail.

No changes are being made to the document to address this comment.

Comments: 06-54, 06-56

Summary: SD05 - A comment was made that a more simplified and straightforward composite sampling model that could be applied for different scenarios would reduce time required for development, review, and approval of such models and ensure consistency in implementation of NRC guidance. The comment suggested that references to academic publications and cautions on use of composite sampling make it difficult to implement or introduce subjectivity in the process thereby limiting its usefulness. Another comment requested practical applications for hard-to-detect radionuclides.

Response: The NRC staff has provided a general approach to conduct composite sampling that is considered simple and straightforward to implement for many cases. However, as the complexity of the problem increases, the licensee may need to utilize more complex approaches to address those complexities. Greater staff review time is expected for more complex cases and earlier coordination of the licensee with NRC staff is encouraged. Complex sampling strategies beyond the scope of the guidance will be evaluated on a case-by-case basis until such time that additional guidance is developed based on industry need.

The text in Section O.3.1.1, Appendix O, NUREG-1757, Volume 2, Rev. 2, was updated to state that the rigor of the review is based on the complexity and risk-significance of the problem.

- *Composite sampling may be used for hard-to-detect (HTD) radionuclides for which an actual MDC_{SCAN} cannot be established (e.g., pure beta or alpha emitter in soil) and there are no surrogate radionuclide relationships available. The composite sampling is used as a method to increase the probability of elevated area or hot spot detection and as a means to reduce analytical cost. However, more complex problems would require more rigorous reviews and will be evaluated on a case-by-case basis. As such, this guidance provides only a general scenario and the associated variables. If composite sampling is proposed to alleviate sampling requirements associated with HTD radionuclides, the licensee should contact the NRC early in the process to discuss the acceptability of the proposal*.

Comments: 06-55

Summary: SD06 - A comment was made that composite sampling would not be beneficial for Class 2 and 3 survey units given the stringent MIL requirements that would need to be a fraction of the reclassification investigation level. Additional clarification in the guidance was requested.

Response: The commenter is correct that the statements appear contradictory as written. While use of composite sampling for Class 2 and 3 survey units in the FSS does not appear to be beneficial, the use of composite sampling is not precluded. The text is simply trying to point out that it could be done but that it is not likely a good use of composite sampling. The text will be clarified to better make this point.

The text in Section O.3.1.1, Appendix O, NUREG-1757, Volume 2, Rev. 2, was updated as follows:

- *Composite sampling may be used during characterization or to provide additional FSS survey unit coverage for Class 2 and 3 areas to ensure proper classification of the unit; however, because Class 2 and Class 3 survey units should not have residual contaminant concentrations in excess of the $DCGL_W$ when properly classified, under most FSS conditions, there is limited, if any, benefit to composite sampling in properly classified Class 2 or 3 FSS units. Use of composite sampling in these classifications would necessitate application of an MIL that is a fraction of the reclassification investigation level.*

Subject: 5 - Subsurface Survey and Dose Modeling

Comments: 02-03, 02-04

Summary: ST01 - A comment was received indicating that more examples of use of geostatistics or approaches for subsurface survey design are needed, including examples for buried waste at the U.S. Department of Defense (DoD) and NRC/AEC licensees or subsurface residual radioactivity associated with commercial nuclear reactors.

Response: Appendix J in NUREG-1757, Volume 2, Revision 1, provides guidance on dose modeling considerations for historical onsite burials, and Appendix J in Revision 2 was broadened to include other types of buried residual radioactivity including radioactivity associated with large reactor basements. NRC staff recently issued updated guidance on alternative disposal requests or ADRs (ADAMS Accession No. ML19295F109) that include onsite burials that are evaluated on a case-by-case basis and require NRC staff approval. Historical information about onsite burials under NRC's previous 10 CFR 20.304 is also included in the ADR guidance.

Under a separate initiative, subsurface guidance is being developed with the assistance of an NRC contractor, SC&A. A technical white paper will include additional examples as requested in this comment and is expected to be issued in fiscal year (FY) 2022 with subsurface guidance issued shortly thereafter. To support development of the subsurface guidance, a subsurface workshop was held July 14-15, 2021. Workshop presentations can be found at ADAMS Accession No. ML21208A206. Several examples were provided in the workshop of subsurface investigations where geostatistical tools were used to facilitate sampling design, remediation, and surveys of excavations. Tools that could be used to develop site conceptual models, identify potential source areas, and aid in survey design and data analysis were also discussed. A second workshop is planned in 2022. As additional guidance and tools are developed in this area, NRC staff will post the information on its decommissioning web site to keep stakeholders informed of progress in this area.

No changes are being made to the document to address this comment.

Comments: 05-02

Summary: SS02 - A comment was made regarding the need for guidance on survey of hard-to-detect radionuclides in the subsurface.

Response: The NRC staff is actively working with one of its contractors to develop guidance on surveys for subsurface radiological contaminants. This guidance will identify specific method(s) to be used to identify the subsurface hard-to-detect radionuclides during a radiological survey and how to address subsurface contaminants through modeling. A minimum level of sampling will be necessary to determine the nature and extent of hard-to-detect radionuclides in the subsurface in any proposed methodology. A technical white paper is expected to be published in FY2022 with agency guidance on subsurface surveys expected to be published shortly thereafter.

No changes are being made to the document to address this comment.

Comments: 05-03, 09-23

Summary: SS03 - Questions were raised regarding the need for a Contamination Concern Map (CCM) that supports conceptual site model (CSM) development as expressed in NUREG/CR-7021. A commenter requested whether the requirement for a CCM would be added to Volume 1, Appendix D.

Response: CCMs are not a regulatory requirement. CCMs are discussed in NUREG/CR-7021 as a potential tool to assist with survey design, remedial and compliance decision-making for complex sites with significant subsurface contamination. Nonetheless, the licensee should understand the nature and extent of residual radioactivity at its site sufficient to properly design and execute a FSS to demonstrate compliance with radiological criteria for license termination. Therefore, a CCM will not be added to the NUREG-1757, Volume 1, Appendix D, checklist.

While a summary of the approaches developed in NUREG/CR-7021 is provided in Appendix G for subsurface residual radioactivity, additional interim guidance on subsurface investigations including conduct of radiological surveys and dose modeling is forthcoming and is planned to be published in FY2022 independent of final revisions to this guidance document. A public workshop is also planned for 2022 to discuss proposed approaches and potential tools to be developed to support subsurface investigations. The interim subsurface guidance will be included in the next revision to NUREG-1757, Volume 2.

As stated above, the concept of a CCM was developed in an NRC publication, NUREG/CR-7021 and is not included in MARSSIM guidance. Furthermore, MARSSIM does not address subsurface residual radioactivity for which the CCM methodology was developed. MARSSIM does include a section on development of CSM (Section 3.6.4 of draft Rev. 2).

No changes were made to the document based on this comment.

Comments: 06-46

Summary: SS04 - A comment was made that insufficient guidance is provided on an acceptable sampling density or a method to determine an acceptable sampling density for residual radioactivity in the subsurface.

Response: Under contract with SC&A, NRC is in the process of developing technical guidance related to subsurface investigations. Additionally, NRC is scoping out potential tools that can be used to aid in the design of surveys for subsurface residual radioactivity to be included in an upcoming version of Visual Sample Plan. Proposed methods being considered include Bayesian Ellipgrid which is based on the probability of detection of an elevated area of a certain size to guide an initial survey design. This approach would use prior information (e.g., knowledge from a historical site assessment) on the probability of an elevated area existing in various parts of the site. An example is provided in NUREG/CR-7021 where the location of the samples is optimized based on prior information. Markov Bayes and indicator cokriging where the data collected from the initial survey based on Bayesian Ellipgrid are converted to 1s and 0s (based on being over or under the release criteria) are being considered to assist with a secondary survey design. These tools or other tools will be incorporated into Visual Sample Plan under a separate contract to assist with design of surveys. A technical white paper will be available in the FY2022 timeframe with subsurface survey guidance being developed shortly thereafter. A public workshop will be held in 2022 to discuss proposed methodologies and potential tools to assist with subsurface investigations. This information will be shared with interested stakeholders as soon as it becomes available.

A significant amount of text was added to Section G.3.1, Appendix G, NUREG-1757, Volume 2, Rev. 2, regarding outcomes from the July 2021 subsurface workshop, and NRC staff plans to develop additional guidance and tools to handle subsurface survey designs and data analysis.

Information about the July 2021 subsurface workshop was added to the end of Section G.3.1, Appendix G, NUREG-1757, Volume 2, Rev. 2, beginning with the following: *A workshop was held on July 14-15, 2021 to discuss radiological surveys and dose modeling associated with subsurface residual radioactivity...*

Comments: 06-47

Summary: SS05 - A comment was made that additional information is needed regarding sample density and use of in-situ gamma spectrometry as a method of performing radiological surveys of open excavations.

Response: Section G.3.2.1, Appendix G, NUREG-1757, Volume 2, Rev. 2, indicates that it is a reasonable expectation to perform a FSS on an open excavation prior to back-filling. This is because it is much more difficult to survey the soil following backfill of the excavation, particularly if the excavation is at depth. The guidance in Appendix G goes on to state that MARSSIM survey classification and design approaches would be acceptable to use for the open excavation—essentially, the open excavation can be treated as a surface and MARSSIM can then be used on the exposed surface. To avoid redundancy with other sections of the guidance document, including Chapter 4 and Appendix A, NRC staff sees no need to repeat MARSSIM guidance for surfaces of open excavations in this section.

For example, MARSSIM guidance would apply to the open excavation with respect to classification and sample requirements. If soil removal is used to meet release criteria, it is reasonable to classify the bottom of the hole as a Class 1 survey unit with 100 percent scanning required for the bottom of the hole. Section G.3.2, Appendix G, NUREG-1757, Volume 2, Rev. 2, provides flexibility for classification of the side walls of the excavation depending on the slope and contamination potential of the side walls.

Every situation is unique and other methods may be proposed by the licensee that could be found acceptable by the NRC staff. Additional examples and guidance will be developed as part of interim guidance planned to be issued for public comment after Revision 2 is published, as described in comment responses 2-3, 2-4, 5-2, and 5-3. NRC staff encourages the licensee to work with the NRC staff early on in the process, particularly if significant soil excavation is required to demonstrate compliance with release criteria.

In certain situations, in-situ gamma spectrometry may be acceptable for use in survey of open excavations. For example, if scanning poses health and safety concerns of personnel, the NRC staff has, in the past, accommodated use of in-situ gamma spectroscopy as a substitute for sampling and/or scanning described in MARSSIM.

In-situ gamma spectroscopy poses its own technical challenges for adequately characterizing a site and should be discussed with NRC staff. NRC staff is currently reviewing proposed approaches for use of gamma spectrometry and will provide additional guidance in this area in the future.

Additional detail is provided in Sections G.3.1 and G.3.2, Appendix G, NUREG-1757, Volume 2, Rev. 2, to address this comment. For example, the following text was added to Section G.3.2:

In cases where health and safety of personnel may be compromised by sampling or scanning, the NRC staff has, in the past, accommodated use of in-situ gamma spectroscopy as a substitute for sampling and/or scanning described in MARSSIM. In-situ gamma spectroscopy poses its own technical challenges for adequately characterizing a site and should be discussed with NRC staff if a licensee feels it presents the best solution to an unsafe working environment.

A significant amount of text was added to Section G.3.1, Appendix G, NUREG-1757, Volume 2, Rev. 2, on dose modeling considerations for buried residual radioactivity and other workshop findings. Two paragraphs beginning with the following were added to Section G.3.1: *Dose modeling and DCGL development considerations for subsurface residual radioactivity was one of several topics at a July 14-15 and subsurface soils survey workshop (ADAMS Accession No. ML21208A206)*…. Text modifications and a figure were also added to the same section.

A significant amount of text was added to Section G.3.2.1, Appendix G, NUREG-1757, Volume 2, Rev. 2, on challenges associated with surveys of open excavations and chasing a subsurface plume. A text box was added Section G.3.2.1 titled *Challenges Associated with Surveys of Open Excavations*.

Comments: 06-48, 09-25

Summary: SS06 - A comment was made in regard to a statement made in NUREG-1757, Volume 2, Rev. 2, that Scenario B could be used to show indistinguishability from background for offsite soils used for back-fill. The comment indicated that it would be impractical to survey large volumes of material brought to the site, and that NRC should consider alternative methods for sampling and analysis to demonstrate indistinguishable from background for backfill materials. Another comment requested clarification on survey requirements for backfill soils used during license termination activities, including non-impacted off-site soils and requirements for decommissioning plans and final status survey reports (FSSR).

Response: The quote was taken out of context. The statement in NUREG-1757, Volume 2, Rev. 2, regarding use of Scenario B was preceded by *If there is uncertainty that backfill soils are non-impacted, one potential method to support this assumption of no added residual radioactivity would be to use a two-sample statistical test such as Scenario B*…. Furthermore, the end of the paragraph indicates that although some form of radiological survey is expected, other approaches methods may be available to show that backfill materials are free of residual radioactivity.

Scenario B was just one proposed method to show that the soils planned for reuse are clean, if there is a reasonable concern that the soils might be impacted. Other supporting information could also be provided to support the assumption that the soils are clean. Licensees should work with NRC staff to discuss alternatives for surveys of backfill materials and proper assessment of risk associated with potential residual radioactivity in backfill soils.

The text will be clarified to state that *support* can be provided to show backfill soils are free of residual radioactivity (versus *an analysis should be performed* …) in consideration of alternatives for providing support that offsite soils are *clean*.

The licensee should demonstrate that backfill soils used during license termination activities are not radiologically contaminated from an off-site source that would cause dose to a critical member of the public to be in excess of NRC regulatory limits. This condition does apply to soil imported from offsite sources. The term non-impacted is normally related to previous licensed activities of the program that is under decommissioning. However, backfill soil can come from a variety of locations throughout the country and thus the term non-impacted is conditional. It is not unheard of that backfill material came from a known radiological source and negatively impacted a different site.

Licensees are encouraged to provide a plan for the evaluation of any backfill soil as early as possible to ensure that NRC staff is aware of any conditions which may increase dose to a member of the public from the site. If the licensee waits until submitting the FSSR to provide that information, the licensee takes the risk of having incomplete information or inadvertently introducing a source term that will impact license termination.

NRC staff also believes it is necessary to characterize any soil reused from the site as backfill to the rigor of a FSS in order to appropriately address dose contributions from that source. Scanning and representative sampling in 6" lifts taken as a soil stockpile is generated or as an excavation is backfilled is a common method. Surface surveys only of a backfilled excavation are likely insufficient unless the backfill is of minimal depth. DQOs should address this issue.

Section G.3.2.2, Appendix G, NUREG-1757, Volume 2, Rev. 2, was updated as follows: *Licensees have typically proposed to use backfill from non-impacted areas onsite or from offsite locations. If the licensee is assuming there is no added residual radioactivity in the backfill, support should be provided for this assumption (i.e., that the backfill soils do not contain residual radioactivity).*

Comments: 09-26

Summary: SS07 - One comment sought clarification on the survey requirements for reuse of materials onsite and whether reuse plans should be included in Appendix D of Volume 1.

Response: The final configuration of residual radioactivity at a decommissioning site should be the basis for the demonstration of compliance with radiological criteria for license termination. Therefore, soil reuse plans are considered an essential component of the decommissioning plan. Recent lessons learned from decommissioning complex materials sites suggest that there is a lack of understanding of the importance of the final distribution of residual radioactivity (horizontal and vertical extent) to dose and inadequate survey of soils prior to reuse. While the depth and thickness of residual radioactivity is important to DCGL derivation, there seems to be a widespread misconception that DCGLs derived for deep surface soils can be used for near surface soils or that the risk from reuse of slightly contaminated surface soils below the DCGLs does not need to be considered in the compliance demonstration. When subsurface residual radioactivity is present and remediation is planned, the licensee should clearly lay out its plans for reuse of soil; the basis for its selection of DCGLs (area, thickness, and depth of residual radioactivity) or the need for multiple sets of DCGLs for different subsurface soil layers; the expected final configuration of residual radioactivity at the site; and details of its plans to perform a FSS to support license termination. See presentations by Barr and Yu (2021) from the July 14-15, 2021, Subsurface Soils Survey workshop that detail the types of analyses that would need to be conducted for residual radioactivity in surface and subsurface soils (ADAMS Accession No. ML21208A206).

This comment will be forwarded to the NUREG-1757, Volume 1 working group for consideration in the DP checklist found in Appendix D of Volume 1.

No change is being made to Volume 2 in response to this comment. The comment will be forwarded to the NUREG- 1757, Volume 1 working group.

Comments: 09-24

Summary: SS08 - A comment was raised that sheet piling would preclude surveys of the walls of an excavation and that excavations would require stepped or sloped sidewalls to allow surveying. A request was made to provide perspective on surveying expectations for a situation where sheet piling was being used.

Response: Staff added clarification to this section to state that sheet pilings may make the sidewalls inaccessible for direct surveying/sampling efforts.

Section G.3.2.1, Appendix G, NUREG-1757, Volume 2, Rev. 2, text was updated as follows:

Deep excavations may require significant preparatory work both to perform the excavation and to make an excavation safe to access, examples of this include pumping to lower the water table, use of sheet pilings to shore up excavation side walls (likely making the sidewalls inaccessible for direct surveying/sampling efforts).

Subject: 6 - ALARA

Comments: 00-19, 00-24, 00-30

Summary: AL01 - Comments were received regarding the 3 and 7 percent discount rates used in as low as is reasonably achievable (ALARA) examples in Appendix N that they stated were withdrawn in 72 FR 46102. Additionally, the commenter inquired about differences in the 1 percent real rate in 10 CFR 20.1403(c)(1). Another comment was made to include a link to a website that calculates a more realistic discount rate. Finally, another comment indicated that the discount rate for long-lived Th-232 should be zero and indicated that the ALARA results were sensitive to discount rate (this comment was in contrast to a short-lived radionuclide used in Example 3 with a discount rate of 3 percent).

Response: The NRC uses the Office of Management and Budget's guidance on discount rates for its cost-benefit analyses (e.g., regulatory analysis, backfitting analysis, and environmental analyses) as described in NUREG/BR-0058, *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission*. Office of Management and Budget's (OMB's) basic guidance on the discount rate is provided in OMB Circular A-94.

The Federal Register notice, 72 FR 46102, did not withdraw the discount rates of 3 and 7 percent. The Federal Register notice withdrew the statement to use 7 percent for the first 100 years and then use a 3 percent rate after 100 years. Example 3 was changed to a short-lived radionuclide, Co-60, from a relatively longer-lived radionuclide, Ra-226. The reason for the changes is that for longer-lived radionuclides, NUREG/BR-0058, *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission* recommends performing additional sensitivity analysis with lower discount rates. Rather than adding in extra sensitivity analysis to Example 3, and to be consistent with the NUREG/BR-0058 guidance, the example was changed to include a relatively short-lived radionuclide, Co-60, and an analysis using only a single discount rate.

The 10 CFR 20.1403(c)(1) reference to 1 percent real rate of return on investment is a rate recommended for decommissioning financial assurance and is not applicable to ALARA analyses conducted in accordance with license termination rule criteria found in 10 CFR Part 20, Subpart E.

As explained further in OMB Circular A-94, interest rates are measured in real or nominal terms. A real rate is adjusted to eliminate the effect of inflation and is used in discounting, a technique used in economic analysis to compare costs and benefits that occur over different periods of time on a consistent basis. A real discount rate is approximated by subtracting the expected rate of inflation from a nominal interest rate.

Appendix E to NUREG/BR-0058, Rev. 5 (draft final) attached to SECY-20-0008 (ADAMS Accession No. ML19261A287) specifically addresses intergenerational cost benefit assessments as follows:

For certain regulatory actions, such as those involving decommissioning and waste disposal issues, the regulatory analysis may have to address consequences that can occur over hundreds, or even thousands, of years. The OMB recognizes that special considerations arise when comparing benefits and costs across generations. Under these circumstances, the OMB continues to see value in applying discount rates of 3 and 7 percent. However, ethical and technical arguments can also support the use of lower discount rates. Thus, if a rule will have important intergenerational consequences, the analyst should consider supplementing the analysis with an explicit discussion of the intergenerational concerns, such as how the regulatory decision will affect future generations. Additionally, supplemental information could include a presentation of the costs and benefits at the time they are incurred with no present-worth conversion (e.g., no discounting). In this case, the resulting net cost should not be calculated.

While NRC staff acknowledges the potential sensitivity of the results to discount rate and encourages sensitivity analysis for longer assessment periods, the radionuclide evaluated in Example 3 is Co-60, which has a half-life of 5 years. A single discount rate of 0.03 was used in the example consistent with current guidance. Because of the relatively short half-life of Co-60, the results would be less sensitive to lower discount rates compared to analyses with longer-lived radionuclides such as Th-232.

No changes are being made to address this comment.

Comments: 00-20, 00-32

Summary: AL02 - A comment was received regarding the need for more information on what constitutes "prohibitively expensive" in 10 CFR 20.1403(e)(2). The commenter also inquired if approval could be granted for a licensee to use a factor less than 10 times the value of averted dose in demonstrating a remedial alternative is prohibitively expensive based on safety considerations. The commenter indicated that in cases where financial information is undisclosed, it would be difficult to determine that the entity is financially incapable of safely carrying out decommissioning.

Response: Section N.6, Appendix N, NUREG-1757, Volume 2, Rev. 2, *Demonstration of "Prohibitively Expensive"*, provides guidance on how to demonstrate that it would be prohibitively expensive to meet the lower dose limit of 1 mSv/yr, compared to the higher allowable dose limit of 5 mSv/yr, in the case that ICs were no longer in affect (see 10 CFR 20.1403(e)). A factor of ten times the value of the Value of averted dose (V_{AD}), where V_{AD} is the value of averted dose, could be used in the analysis to show that meeting the 1 mSv/yr standard is prohibitively expensive, although use of a lower factor may be appropriate in specific situations when the licensee could become financially incapable of carrying out decommissioning safely. See Section N.6, Appendix N, NUREG-1757, Volume 2, Rev. 2, for additional information.

To use a factor less than 10 times the value of averted dose in demonstrating that further remediation necessary to meet the 1 mSv/yr standard is prohibitively expensive, the licensee would need to provide justification for use of the lower factor. If such information is not provided, the factor of 10 times the values of averted dose should be used to demonstrate that the § 20.1403(e) requirement has been met.

No change is being made to the document to address the comments.

Comments: 00-21

Summary: AL03 - A comment was received indicting that additional guidance on how to conduct a qualitative ALARA analyses is needed.

Response: Almost any evaluation can be qualitative vs quantitative. A well thought out, qualitative evaluation of certain impacts that are difficult to assess numerically can be used to support the ALARA analysis. For example, it could be very difficult to realistically anticipate potential future land use over long time periods and accurately estimate potential future costs associated with loss of value of property. Interaction with the NRC staff early in the process is recommended when a licensee makes qualitative arguments, which are more difficult to assess compared to quantitative analyses. It's usually simpler and easier to do a numerical justification when information and data are available to perform such an analysis.

Section N.6, Appendix N, NUREG-1757, Volume 2, Rev. 2, provides an example of an impact that would be difficult to evaluate quantitatively. For example, environmental degradation is not easy to quantify. As further stated in the guidance document, placing a monetary value on certain types of impacts can be difficult. Section 3.4.1 of NUREG-1854 also provides additional examples of impacts that are not conducive to quantitative analysis. Due to the difficulty in developing generic guidance in this area, qualitative arguments will be evaluated on a case-by-case basis.

No changes are being made to the document in response to this comment.

Comments: 00-22

Summary: AL04 - A comment was received requesting clarification of a statement made in the guidance that a licensee does not need to perform an ALARA analysis to justify performing a remedial action.

Response: The comment pertains to text that was present in Revision 1 of the guidance document. The guidance simply states that if the licensee has already decided to perform a remedial action, there is no need to analyze whether the action was necessary to meet the ALARA requirement. The analysis described in this section is needed only to justify not taking a further remedial action to reduce doses below the dose standard. For example, if a licensee plans to wash surfaces in a room (either to meet the dose limit or as a good practice), there is no need to analyze whether the remedial action of washing is necessary to meet the ALARA requirement. This means that an ALARA analysis is not required prior to taking remedial actions. An ALARA analysis determines whether additional actions are required to get below the dose standard, but if a licensee decided to do a specific remediation activity before completing an ALARA analysis (for any reason), then they don't need to do ALARA analysis for that action.

No changes are being made to the document in response to this comment.

Comments: 00-23, 00-25

Summary: AL05 - Editorial comments were received indicating that (i) Section N.2.7 was cross referenced but that Section N.2.7 does not exist, (ii) that the units for activity concentration in soil should be activity per unit weight.

Response: The commenter is correct that there is no Section N.2.7 in Appendix N to NUREG-1757, Volume 2, Rev. 2. Reference to Section N.2.7 was a typo. The cross-reference should be to Section N.3.7. Also, NRC staff agrees that the concentration should be expressed in activity per unit mass.

The cross-reference was changed to Section N.3.7 and the activity units were changed to activity per unit mass in equation N-2

Comments: 00-26

Summary: AL06 - A comment was made requesting additional guidance on costs associated with property value for restricted release cases.

Response: NRC staff recognizes the difficulty in determining impacts of the presence of residual radioactivity on property values. The following two references may be useful to address the impact of nuclear power plants and the effects restricted and unrestricted land has on property values:

1. NUREG/CR-0454, Effects of Nuclear Power Plants on Community Growth and Residential Property Values (ADAMS Accession No. ML12338A386)

2. Nieves, L.A., R.C. Hemphill, and D.E. Clark, *The Economic Impacts of Noxious facilities on Wages and Property Values: An Exploratory Analysis*, ANL/EAIS/TM-67, U.S. Department of Energy, May 1991. Accessible at https://www.osti.gov/servlets/purl/5606407

These two references will be included in Appendix N on property values. Reasonable estimates of costs associated with restricted release can be considered in determining whether further reductions in residual radioactivity to comply with unrestricted release were not being made because the residual levels associated with restricted release are ALARA.

The two references were added to Section N.3.2.3, Appendix N, NUREG-1757, Volume 2, Rev. 2.

Comments: 00-27

Summary: AL07 - A comment was made seeking clarification regarding incremental versus total costs and whether costs associated with remobilization should be considered.

Response: The costs to be considered in the ALARA analysis are only the costs of remediation below the dose limits. However, licensees may consider all costs of the further remediation, which may vary depending on when in the decommissioning process the ALARA analysis is conducted. As the comment notes, at some points in the remediation process, further reductions to ALARA levels may have only minor incremental costs above the cost for remediation to the dose limits, but if ALARA remediation is performed as a second round of remediation, some activities, such as mobilization, will have to be performed twice, which may substantially increase the cost of ALARA remediation.

An ALARA analysis could also be performed to demonstrate that the entry requirements for restricted release are met (i.e., that the residual radioactivity levels could not be further reduced to meet the unrestricted release dose standards found in 10 CFR 20.1402). The costs associated with restricted release (e.g., regulatory, land value, esthetics/public opposition) could be added to the benefits of unrestricted use when comparing unrestricted and restricted release alternatives as discussed in Section N.3.2.1, Appendix N, NUREG-1757, Volume 2, Rev. 2.

NRC staff acknowledges that the costs could be artificially inflated due to a number of factors. In fact, the Section N.1, Appendix N, NUREG-1757, Volume 2, Rev. 2, bullet *The method is usable as a planning tool for remediation* explicitly states that establishing ALARA post remediation could also result in it being less likely for a licensee to remediate below the dose limit(s) because of the additional manpower startup costs associated with performing additional remediation. Therefore, NRC staff believes that ALARA evaluations should be conducted early on in the process to evaluate the incremental costs associated with additional removal below the dose standard to avoid a situation where the potential costs are inflated solely due to the timing of the analysis or underlying assumptions.

No change is being made to the document to address this comment.

Comments: 00-28

Summary: AL08 - A comment requesting updated ALARA references in Table N.2 was provided.

Response: Updated references and values are included in Table N.2. The title of Table N.2 was also changed to recognize that the values will change over time. Licensees may use any values so long as they are justified. As noted by this comment, any updated values staff substituted are transitory in nature as the values are routinely reevaluated in various scientific and regulatory fields of study.

Updated values and title of Table N.2 *Parameter Values used in ALARA Examples*

Comments: 00-29

Summary: AL09 - A comment compares the concentration level that is ALARA using an alternative discount rate of 0.25 percent versus a 7 percent discount rate used in the current example 1.

Response: The NRC staff acknowledges the calculation provided in the comment. The example in NUREG-1757, Volume 2, Rev. 2, was presented to show what the ALARA concentration would be for the current discount rate recommended in OMB Circular A-94. Sensitivity analyses could be conducted using lower discount rates for longer lived radionuclides covering longer assessment periods.

No changes are being made to address this comment.

Comments: 00-31

Summary: AL10 - A comment was received requesting additional guidance on consideration of naturally occurring radioactivity in groundwater (e.g., uranium and radium) versus residual radioactivity that a licensee is responsible for.

Response: As stated in NRC's regulations, only residual radioactivity distinguishable from background is considered in assessing whether the dose standards are met. For example, unrestricted release standards found in 10 CFR Part 20, Subpart E, state the following:

> § 20.1402 Radiological criteria for unrestricted use.
>
> A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are ALARA. Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

Residual radioactivity is defined in § 20.1003 and indicates that background radiation is excluded:

> Residual radioactivity means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes radioactivity from all licensed and unlicensed sources used by the licensee but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of 10 CFR part 20.

Section N.3.7, Appendix N, NUREG-1757, Volume 2, Rev. 2, was updated to reflect the potential need to distinguish between residual radioactivity under the licensee's control and background radioactivity.

The following sentence was added to the text in Section N.3.7, Appendix N, NUREG-1757, Volume 2, Rev. 2:

Also, it may be necessary for a licensee to use upgradient wells to determine a background level of radioactivity in groundwater to assess that radioactivity resulting from licensed operations. Additional information related to groundwater monitoring can be found in Appendix F.

Comments: 00-33

Summary: AL11 - One comment requested clarity on what benefits and equations would apply to restricted release and eligibility cases referred to in Section N.7 and requested that the section be moved to the beginning of Appendix N.

Response: Equation N-2 listed in Section N.3.2, Appendix N, NUREG-1757, Volume 2, Rev. 2, *Calculation of Benefits*, and Equation N-8 listed in Section N.3.4, Appendix N, NUREG-1757, Volume 2, Rev. 2, *Residual Radioactivity Levels that are ALARA for Unrestricted Use*, are used to perform ALARA analyses. Section N.3.4 states that for restricted release, the NRC staff and licensees should modify the equations to include the additional benefits that are only applicable to comparisons between unrestricted and restricted release. As stated in text introducing Table N.1 in Section N.3.1: Table N.1 gives an example of various benefits and costs. Other than Collective Dose Averted, the additional benefits listed are generally only important in comparisons between alternatives that address whether the licensee can pursue restricted release. The benefits that should be included when comparing unrestricted and restricted release scenarios include the following: *regulatory costs avoided*, *changes in land values*, *esthetics*, and *reduction in public opposition*.

Section N.7, Appendix N, NUREG-1757, Volume 2, Rev. 2, simply provides the derivation of the equations provided in N-2 and N-8 in earlier sections. NRC staff see no compelling reason to provide additional detail on the derivation of the ALARA equations prior to the restricted use and eligibility discussions as requested by the commenter.

The ambiguous statement in Section N.7, Appendix N, NUREG-1757, Volume 2, Rev. 2, will be revised to explain what benefits and equations are being referred to in Section N.7.

Section N.7, Appendix N, NUREG-1757, Volume 2, Rev. 2, text was revised as follows:

The following derivation applies to an ALARA evaluation for license termination for unrestricted use with "collective dose averted" being the only benefit considered in the equations below. Additional benefits listed in Table N.1 would apply to restricted use cases, and the equations below would be modified to consider the additional benefits listed in Table N.1.

Comments: 00-34

Summary: AL12 - One comment requested that the guidance be clarified to indicate that ALARA analyses not be used to justify reductions in residual radioactivity that are necessary to meet the applicable dose standard.

Response: The NRC staff agrees with the commenter that ALARA analyses should not be used to justify not performing remediation to meet the dose standard. In fact, the definition of ALARA states "to maintain exposures to radiation *as far below the dose limits…*". A clarifying statement was added to Section N.7, Appendix N, NUREG-1757, Volume 2, Rev. 2, to make this clear as suggested in the comment.

The following sentence was added to Section N.7, Appendix N, NUREG-1757, Volume 2, Rev. 2, to address this comment:

In all cases, the radiological criteria for license termination found in 10 CFR Part 20, Subpart E must be met, and ALARA evaluations should not be used to justify neglecting a remedial action necessary to meet the radiological criteria for license termination.

Comments: 00-35

Summary: AL13 - A comment was made requesting that units and variables be defined in equations N-18 and N-29. An ALARA example for soils was also requested.

Response: Equations N-18 through N-29 are simply a derivation of equations N-2 and N-8 first presented in Sections N.3.2.1 and N.3.4, Appendix N, NUREG-1757, Volume 2, Rev. 2. An explanation of the variables and units, when applicable, are imbedded in the text preceding each equation (e.g., see text associated with equations N-1 and N-2 in Section N.3.2.1) and some are found in Table N-2. NRC staff does not see a significant need to explicitly state each variable for each equation. An example for soil removal is given as Example 3 in Section N.3.5, Appendix N, NUREG-1757, Volume 2, Rev. 2.

No changes are being made to the document in address this comment.

Comments: 05-06

Summary: AL14 - A comment was raised that guidance on the long-term costs associated with regulated restricted release sites should be included.

Response: Bullet 2 in Section N.3.2.2, Appendix N, NUREG-1757, Volume 2, Rev. 2, indicates the financial assurance necessary for long-term maintenance and control could be avoided if pursuing unrestricted release. While not specifically calling out long-term regulatory costs here, it is NRC staff's belief that this is relatively intuitive to this discussion as the licensee's financial assurance is meant to cover all costs relating to decommissioning.

With regard to financial assurance guidance for restricted release sites, see NUREG-1757, Volume 3, Section 4 for additional information.

Staff added a parenthetical reference to NUREG-1757, Volume 3, Section 4 to the 2nd bullet of this section.

Comments: 06-23

Summary: AL15 - A comment was made that the licensee having to show that residual radioactivity was indistinguishable from background to alleviate the need for ALARA evaluations was too restrictive. Instead the licensee should only need to show that the dose from the residual radioactivity is less than 10 percent of the dose criteria.

Response: As stated in the guidance, soil removal for unrestricted release is not likely to be cost effective.

> *For residual radioactivity in soil at sites that may have unrestricted release, generic analyses (see NUREG-1496 and the examples in Section N.2.5) show that shipping soil to a licensed low-level waste disposal facility is unlikely to be cost effective for unrestricted release, largely because of the high costs of waste disposal. An ALARA analysis is not needed for soil removal to meet unrestricted release at or below a dose criterion of 0.25 mSv (25 mrem) per year…Therefore, the licensee generally does not have to evaluate shipping soil to a low-level waste disposal facility to achieve exposure levels at or below the criterion for unrestricted release. However, this conclusion may not hold for waste disposal at locations other than licensed low-level waste disposal facilities.*

Although disposal to another (non-LLW) disposal facility could potentially be cost effective, it is unlikely that would be the case unless the disposal facility was very close to the decommissioning site. Qualitative arguments could be presented to demonstrate residual radioactivity levels are ALARA based on NUREG-1496 analyses.

No changes are being made to the document to address this comment.

Comments: 09-43

Summary: AL16 - A question was raised about the need to consider collective doses contributions for very tiny or negligible doses for groundwater discharges to surface water at downgradient locations.

Response: To avoid a situation where a remedial action is taken to avert negligible doses, Section N.3.6, Appendix N, NUREG-1757, Volume 2, Rev. 2, *When Mathematical Analyses are Not Necessary* provides that a licensee would not be expected to perform an ALARA analysis for cases where no residual radioactivity distinguishable from background remains or will remain on the site at the time of license termination. A Scenario B (see Section 2.4, Chapter 2, NUREG-1757, Volume 2, Rev. 2) or other type of analysis could be conducted to make this demonstration.

The NRC staff agrees that large collective doses could occur at insignificant doses. Technical issues associated with collective dose calculations and the linear no-threshold model are policy issues outside of the scope of this guidance. However, approaches are available to address this issue including a relative comparison between various alternatives as described in Section N.3.1, Appendix N, NUREG-1757, Volume 2, Rev. 2.

No changes are being made to address this comment.

Subject: 7 - General/Process

Comments: 00-00, 02-01, 03-01, 05-07, 09-01

Summary: GE01 - General positive comments were provided regarding the revision, its usefulness to various state or industry programs. One comment indicated that the revision reflected a great deal of hard work to address complicated issues. Another comment indicated that the document was well written. Another comment indicated that the opportunity to provide technical feedback would be helpful to making the document more useful to its licensees. Another comment indicated that inclusion of lessons learned and references with examples is helpful for perspective on implementation of the requirements.

Response: We appreciate the very helpful and thoughtful comments we received on the draft NUREG-1757, Volume 2, Rev. 2 guidance document. NRC staff will work with our stakeholders to continue to address the comments and improve our guidance in future revisions.

Comments: 00-05, 06-09

Summary: GE02 - A comment was received that only certain types of licensees should be afforded flexibility in providing less information during the planning stage (e.g., in some cases information could be provided at time of submittal of the FSS design following remediation versus at the decommissioning plan or license termination plan stage). See Method 1 versus Method 2 in Section 4.1.3 of the guidance document. Another comment suggested that it was unclear how Method 1 and Method 2 differed.

Response: NRC staff would note that Method 1 is less restrictive compared to Method 2 with respect to information required at the DP stage. NRC staff assumes the commenter was referring to Method 1 and not Method 2. While the commenter is correct that there is a greater risk of more expensive remobilization under Method 1, the risk is borne by the licensee and not the regulator. It is in the licensee's best interest to work with the regulator early on the process to help ensure a more efficient decontamination and decommissioning process. NRC inspection and oversight during the remedial action and FSS design and implementation stages will mitigate any decision-making risk. The information required and rigor of the review are similar; however, Method 1 provides flexibility in the timing of submittal of the FSS design recognizing that the design approaches and parameters may change following remediation as described in Section 2.2, Chapter 2, NUREG-1757, Volume 2, Rev. 2. Methods 1 or 2 describe the types of information required in a DP; therefore, neither method is applicable to Decommissioning Groups that are not required to submit a DP (i.e., are not required for Decommissioning Groups 1 and 2).

The difference between Method 1 and 2 is that Method 1 allows the licensee to provide information for the FSS design (i.e., Section 4.4, Chapter 4, NUREG-1757, Volume 2, Rev. 2 information following the completion of remediation, recognizing that information collected during the remedial action could be used to design the FSS) at the completion of remediation rather than at the time the decommissioning plan is submitted. On other hand, Section 4.4, Chapter 4, NUREG-1757, Volume 2, Rev. 2, *FSS Design Information*, would be submitted earlier with the decommissioning plan in Method 2.

Due to renumbering of section headings between Rev. 1 and Rev. 2, the NRC staff will change the reference from 4.1 to 4.1.4 to be more specific (i.e., will change the reference from 4.1.4 -4.3 under Method 1 and 4.1.4 -4.4 under Method 2). No other changes are being made to address this comment. No other changes are being made to the document to address this comment.

Comments: 06-00

Summary: GE03 - A general comment was made regarding the usefulness of the guidance document for development of license termination plans, FSSs and associated reporting. The comment notes that the guidance document covers a broad range of facility types and licensees and is necessarily a large compilation of methods but that the ample use of appendices in the revision helps direct users to technical information that is selectively applicable to the unique situations encountered at specific sites. Nonetheless, due to what is perceived to be an increasingly lengthy and burdensome license termination process, the NEI intends to develop a technical report for use by commercial nuclear power plant licensees to guide them through the license termination process. NUREG-1757, Volume 2, was stated to be a key source document for that technical report. NEI offers a number of comments that it believes are necessary to improve the efficiency of regulatory activities associated with license termination. A number of additional comments are summarized in the NEI cover letter that was also provided in the enclosure.

Response: NRC staff appreciates NEI's comments on the draft guidance document. We hope the draft guidance document will be of use to NEI to develop guidance specifically for reactor licensees. NUREG-1700 is also a key guidance document for reactor licensees, and NRC staff plans to work with NEI to develop a crosswalk from NUREG-1700 to NUREG-1757, Vol. 2, Rev. 2 as requested in the comment.

No changes are being made to the document to address this comment.

Subject: 8 - Policy

Comments: 00-06

Summary: PO01 - A comment was raised about onsite burials as a remedial strategy.

Response: Onsite disposal is one alternative method of disposal that may be permitted upon approval by the NRC staff on a case-by-case basis under 10 CFR 20.2002 (previously 10 CFR 20.304 and 20.302) for material such as lab waste, incineration, or contaminated sediment if the dose is less than a few millirem per year (see guidance found at https://www.nrc.gov/waste/llw-disposal/10cfr20-2002-process.html for additional information). Doses from all residual radioactivity remaining at the site following license termination must be considered in demonstrating compliance with the release criteria found in 10 CFR Part 20, Subpart E, including previous disposals authorized under 10 CFR 20.2002.

A footnote will be added to clarify that onsite disposals are authorized under the provisions of 10 CFR 20.2002 on a case-by-case basis.

Comments: 00-16

Summary: PO02 - A question was raised about the need for a safety margin to meet the public dose limit found in 10 CFR 20.1404 of 1 mSv/yr, which considers dose from all man-made sources combined—not including medical for the case of restricted release which also has a 1 mSv/yr dose standard.

Response: The NRC staff does not believe that guidance related to demonstration of compliance with radiological criteria for license termination should specify limits that are more restrictive than the limits provided in the regulations. Changes to NRC's regulations to address concerns with the dose standards would require rulemaking. Specific approaches, including the consideration of each decommissioning action on a case-by-case basis and the use of the ALARA approach help ensure protection of public health and safety. Use of these approaches may ultimately result in dose for a particular decommissioning site that are less than the values provided in NRC regulations.

No changes were made to the document based on this comment.

Comments: 00-36

Summary: PO03 - A comment received from an Agreement State inquired whether States that do not require an ALARA analysis, that do not allow issuance of a long-term control license, or that have different definitions of institutional and engineering controls would not need to follow the guidance document, because the guidance document is Compatibility Category C.

Response: The Compatibility Category for NUREG-1757, Volume 2, Rev. 2, is Category C. Therefore, the Agreement States can have more stringent requirements compared to NRC's regulations. As with all guidance, the guidance presents acceptable approaches to meeting NRC regulations but is not a requirement—other approaches may be available to meet NRC regulations.

No changes are being made to the document to address this comment.

Comments: 03-09

Summary: PO04 - A comment was received that there was a copy and paste error in Step 9 of the figure following Table 1.3 and to correct step 9.

Response: NRC staff assumes that the commenter is referring to Figure 1.2, *Decommissioning and License Termination Decision Framework (Modified from NUREG1549)*. NRC staff do not find any errors in the figure. As discussed, Step 8 is to define the site characterization, remediation, FSS, and restricted use options. Once those options have been defined, Step 9 is to analyze them in terms of cost and likelihood of success.

No changes were made to the document.

Comments: 06-06

Summary: PO05 - A comment was received requesting additional examples or detail on when a licensee would need to coordinate with the NRC to use the flexible approaches described in the guidance document.

Response: Since each review and approval is performed on a case-by-case basis, the methods being used and the assumptions being made will likely vary from site to site. As noted in this section, licensees may propose other, more flexible, approaches than those typically used to demonstrate compliance. These proposed approaches, however, are considered specific to the site and the conditions being evaluated. Due to the uniqueness of each site and the different requirements for each case-by-case review, providing specific criteria or examples to follow in this NUREG would be difficult (i.e., just because it worked for site X doesn't mean it can be used for site Y). Therefore, NRC staff specifically avoided including specific criteria and examples to ensure that sites are being evaluated based on the specific issues associated with a particular site and instead focused on promoting communication between the licensee and the NRC staff.

No changes are being made to the document to address this comment.

Subject: 9 - Guidance Document Organization or Development

Comments: 06-01

Summary: GU01 - A comment was made that while Table 1.1 and 1.2 provide a good overview of applicability the usefulness of the document could be improved by cross walking to NUREG-1700, Rev. 1, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans," so that licensees could readily identify relevant parts for developing a license termination plan.

Response: NRC staff sees value in working with industry to increase the usefulness of NUREG-1757 guidance for nuclear power plants undergoing decommissioning. With regard to the specific comment regarding a cross-walk to NUREG-1700, NRC staff thinks that the cross-walk may be better suited in a location outside of NUREG-1757 because NUREG-1757 is applicable to all types of sites including materials sites undergoing decommissioning. NRC staff will work with NEI to develop a cross-walk to NUREG-1700 and continue to discuss technical areas of concern. Updates to guidance will occur after finalization of this revision to NUREG-1757, Volume 2, and will be shared with interested stakeholders as the guidance becomes available until the guidance can be incorporated into the next revision of the guidance document. Guidance revisions are an area of continuous improvement, and NRC staff believe that at some point, a revision with substantive improvements needs to be published while it continues to improve its guidance based on stakeholder needs.

No changes are being made to the document to address this comment.

Comments: 06-02

Summary: GU02 - A comment was made that the guidance document cite other supporting reference documents in lieu of having to update the references every time the secondary references are updated.

Response: While NRC staff appreciates NEI's recommendation, the purpose of the Consolidated Decommissioning Guidance set is to consolidate NRC's decommissioning guidance into a multi-volume set for ease of reference. In many cases, the guidance is summarized, and additional context is provided to facilitate implementation of external guidance to specific problems NRC licensees face, thereby adding value to the guidance in the specific context with which it is presented. Although this approach requires more effort, NRC staff thinks that the value of such an approach is worth the cost. NRC staff is considering methods to update its guidance more efficiently in the future including updates to single sections of the guidance document and reconstitution of the sections in major revisions to the document at a more regular periodicity.

No changes are being made to the document to address this comment.

Comments: 06-05

Summary: GU03 - A comment was received that the organization of the report with regard to the flow of work does not reflect the actual sequence of decommissioning activities.

Response: While some changes in the report will help alleviate this issue, it is recommended that this topic be a focus of future industry guidance on the license termination process or future reorganization of the NUREG. NRC staff will continue to work with NEI to develop additional guidance that will be of benefit to its licensees.

No changes are being made to the document to address this comment.

Comments: 08-01

Summary: GU04 - A comment listed regulations and guidance applicable to uranium recovery facilities.

Response: The comment indicates that reclamation and decommissioning at uranium recovery facilities is already regulated under 10 CFR Part 40, Appendix A, *Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content*. In support of this comment, the commenter listed NRC guidance that applies to decommissioning of uranium recovery facilities and described a specific example of the uranium recovery industry's experience in modeling buried material at the Sweetwater Uranium Project in Wyoming.

The NRC staff agrees that uranium recovery facility decommissioning is already regulated under 10 CFR Part 40, Appendix A. As noted in Table 1, *Contents and Applicability of Key Decommissioning Guidance Documents*, of draft NUREG-1757, Volume 2, Revision 2, because uranium recovery facilities are not subject to 10 CFR Part 20, Subpart E, the guidance in NUREG-1620, Revision 1, should be used for uranium mills that are subject to 10 CFR Part 40, Appendix A.

No changes are being made to the document based on this comment.

Comments: 09-02

Summary: GU05 - A comment was raised requesting deletion of reference to draft LLW guidance found in NUREG-2175 due to the need for significant revisions prior to finalization based on Commission direction.

Response: The commenter is correct that the draft NUREG-2175 and the draft proposed rule for public comment have not been finalized. Nonetheless, NUREG-2175 represents the latest NRC staff guidance associated with performance assessments for disposal of radioactive waste and is available for use by licensees with complex sites undergoing decommissioning. While portions of the guidance document will be revised based on Commission direction, these sections are not expected to be pertinent to decommissioning licensees and large portions of the technical guidance document will remain unchanged and/or can be incorporated into existing guidance documents such as NUREG-1757, Volume 2, Revision 2.

No changes are being made to the document based on this comment.

Subject: 10 - Editorial

Comments: 03-20

Summary: ED01 - A request was made to delete a duplicative National Academy of Science reference in Table P.4.

Response: Editorial change made; duplicate removed.

The duplicate reference was deleted in Table P.4.

Comments: 03-26

Summary: ED02 - A request was made to change the symbology for the chloride ion consistent with standard chemistry notation; to italicize constants; and to present generic units for corrosion rate (l/t) in the corrosion rate formula in Section Q.5.2.5.

Response: Agreed, changes made to text.

The changes were made to the Section Q.5.2.5, Appendix Q, NUREG-1757, Volume 2, Rev. 2, equation as noted:

C (L/T) = a [Cl-]b

Comments: 03-27

Summary: ED03 - A comment was made that the units in the text associated with the corrosion rate example be mils/yr rather than mils.

Response: The example is referencing total corrosion over an arbitrary time, so *mils* is the correct value. However, to be consistent with the changes to the equation the text was changed to reflect *length units*.

Section Q.5.2.5, Appendix Q, NUREG-1757, Volume 2, Rev. 2, was updated as follows:

For the expression given above, if b = 1.7, then the total corrosion <u>over a particular time</u> estimated at region 4 would be approximately 68 <u>length units</u> (e.g., mils) (from the red dashed line to the left), compared to 170 length units in the highlighted region. In one case, <u>releases</u> may not occur whereas, in the other case, releases may occur, albeit over a smaller area.

Comments: 03-30

Summary: ED04 - Three corrections were suggested in the text in Appendix P: erratic to erratics; Sandia National Laboratory to Sandia National Laboratories; and flux rate to flux.

Response: Editorial changes made.

The editorial changes were made as recommended in the comment.

Comments: 06-14

Summary: ED05 - A comment was received to change DCGLW to $DCGL_w$.

Response: Correction made.

Correction made as recommended in the comment.

Comments: 09-05, 09-21, 09-41

Summary: ED06 - Comments were made to clarify which RESRAD code is being referred to (e.g., RESRAD-ONSITE). A comment requested that the word "-ONSITE" be added to a footnote in Appendix F.

Response: All references to *RESRAD* have been modified to refer to the applicable RESRAD code (i.e., RESRAD-ONSITE, RESRAD-OFFSITE, RESRAD-BUILD). In cases where RESRAD was used as a general term wording was modified to identify the RESRAD family of codes. The word ""-ONSITE" was added to "RESRAD" in a footnote in Appendix F, as recommended.

Applicable changes were made throughout the document.

Comments: 09-09

Summary: ED07 - A comment was made to fix the "W" to subscript in $DCGL_w$.

Response: NRC staff agrees to make the large *W* a subscript after DCGL.

Change made as recommended in the comment.

Comments: 09-28

Summary: ED08 - A comment was made to change Appendix I reference to "systems and components" to "systems" consistent with Appendix F.

Response: NRC staff agrees with the suggested change.

Changed *systems* to *systems and components* as recommended in the comment.

Comments: 09-32

Summary: ED09 - A comment was made requesting an update to the reference for the RESRAD-ONSITE and RESRAD-BUILD User's Manuals.

Response: The original 1994 User's Manual was replaced with the updated User's Manual published in June 2003.

Text in the body of the document was modified to note the updated User's Manual (ANL/EAD/03-1) in Section I.5.3.2 and Section I.5.3.6, Appendix I, NUREG-1757, Volume 2, Rev. 2. The reference section was also updated.

Comments: 09-34

Summary: ED10 - A comment was raised to delete the authors name in the title of a report as the author is cited after the title.

Response: Grammatical correction made.

CE Yu was removed from the reference to be consistent with the rest of the document.

Comments: 09-39

Summary: ED11 - A comment was made to correct the reference to the RESRAD User's Manual in Section I.8.

Response: The Yu, C., reference on page I-114 is for a chapter included in the Health Physics Society 1999 summer school textbook. It is not the same as ANL/EAD-4. The listing was updated to include the entire reference.

The listing in the reference section was updated to include all details …

Yu, C., 1999. RESRAD Family of Codes and Comparison with Other Codes for Decontamination and Restoration of Nuclear Facilities. Chapter 11, pp. 207 – 231 in Decommissioning and Restoration of Nuclear Facilities, Health Physics Society 1999 summer school textbook, M.J. Slobodien (Editor), Medical Physics Publishing, Madison, WI.

Comments: 09-40

Summary: ED12 - A comment was made about missing line numbers and an error in the order of references at the end of Appendix I.

Response: Line numbers will be added.

A more recent, up-to-date version of the reference,

Yu, C., et. al. User's Manual for RESRAD Version 6, Environmental Science Division, Argonne National Laboratory, July 2001, is already included in the list of references so the reference was removed.

Line numbers added.

Changed Yu, C., E. Gnanpragasam, J.J. Cheng, and B. Biwer, Benchmarking of RESRAD-OFFSITE to the following:

— — — — —. ANL/EVS/TM/06-3, Benchmarking of RESRAD-OFFSITE: Transition from RESRAD (onsite) to RESRAD-OFFSITE and Comparison of the RESRAD OFFSITE Predictions with Peer Codes. DOE/EH 0708, ANL: Argonne, IL. May 2006

Comments: 09-50

Summary: ED13 - An editorial comment was made to correct a spelling of the word United States.

Response: The edit was made to the text.

The comment was incorporated (*Unites* was changed to *United*).

Subject: 11 - Engineered Barriers

Comments: 00-01

Summary: EB01 - A comment was made that NUREG-1757, Volume 2, Rev. 2 contains contradictory statements about the need to consider less likely but plausible, disruptive conditions from human and natural events and processes on engineered barriers and later saying that for most cover systems, long-term, passive performance is not well understood. The commenter thinks that disruptive human activities could compromise the ability of engineered barriers to perform and that institutional controls are necessary to ensure that engineered barriers remain in pace and are not removed due to those disruptive human activities. Therefore, the State believes engineered barriers could only be used for restricted release sites.

Response: The NRC staff thinks that the use of engineered barriers in an unrestricted release scenario would be rare but is not prohibited by NRC's regulations. While for most cover systems, *long-term*, passive performance of the cover system cannot be validated, the performance of some engineered cover systems is more certain. Furthermore, not all engineered barriers are cover systems, and not all engineered barriers are relied on for long time periods. While less likely but plausible disruptive human activities should be considered to risk-inform the decision, only reasonably foreseeable exposure scenarios must be considered as part of the compliance demonstration. The likelihood of complete removal of an engineered barrier should be assessed to risk-inform the decision.

Engineered barriers may provide some passive performance even when disturbed. Sufficient information should be provided regarding the function and assumed performance of the engineered barrier and degree to which the engineered barrier is relied on to demonstrate compliance. If ICs are needed to ensure that the engineered barriers perform as assumed to meet the unrestricted release criteria, then an unrestricted release scenario would likely be inappropriate as stated by the commenter. Only the passive performance of the engineered barrier can be relied on for unrestricted release and it must be consistent with the scenarios evaluated.

Section 3.5, Chapter 3, NUREG-1757, Volume 2, Rev. 2, was updated to indicate that while long-term performance of engineered cover systems cannot be validated, *natural analogs (Section P.1.3) and other forms of model support can be used to provide support for the assumed passive performance of some cover systems.*

Comments: 03-16

Summary: EB02 - A comment was made regarding the need for a discussion on the role of covers in limiting biotic intrusion, which is considered to be one of the most significant mechanisms for contaminant transport for some sites.

Response: Biotic transport has been estimated to be the most significant transport pathway at some sites, but this has not been validated. For older sites (prior to decommissioning) and waste disposal sites, water transport pathways and sometimes aeolian redistribution has been observed to be the dominant contaminant transport pathway. As noted by the commenter, biotic impact on engineered covers is mentioned in Appendix P along with physical and chemical degradation processes. At this time, NRC staff believes that NUREG-1757, Volume 2, Rev. 2, provides an appropriate level of detail for referencing biotic processes given observations from many sites and systems.

No change is being made to address this comment.

Comments: 03-17

Summary: EB03 - A request was made to use the term "naturalization" rather than "degradation" when referring to the evolution of engineered cover systems. Natural processes may actually act to enhance cover performance rather than lead to degraded performance.

Response: Most licensees will likely emphasize degradation in their assessments. Naturalization or barrier change would be more neutral terminology. In response to this comment, a footnote was added in Appendix P to indicate that naturalization processes may result in increased performance of a barrier.

The following footnote was added to the first reference to *degradation* in Section P.1.4, Appendix P, NUREG-1757, Volume 2, Rev. 2, *Degradation Mechanisms and Functionality of Common Engineered Barriers*,

Degradation is the negative aspect of the more general naturalization process (NUREG/CP-0195). Some processes, depending on the engineered barrier and site, may enhance barrier performance over time. For example, some cements have been shown to have decreased porosity and increased strength as a result of carbonation. Most licensees will likely emphasize degradation processes in their quantitative evaluations.

Comments: 03-18

Summary: EB04 - A request was made to elevate the outline level of the section entitled "Potential Levels of Functionality and Uncertainty" rather than have it fall under "degradation".

Response: Agreed, text has been changed.

The section *Potential Levels of Functionality and Uncertainty* was elevated from a fifth-level heading to Section P.1.4.2, a fourth-level heading.

Comments: 03-19

Summary: EB05 - A request was made to add NUREG/CR-6948 as a reference to Table P.4.

Response: Agreed, reference added to table.

The following reference was added to Table P.4, Appendix P, NUREG-1757, Volume 2, Rev. 2:

Price, V. T. Temples, J. Tauxe, R. Hodges, R. Falta, Integrated Ground-Water Monitoring Strategy for NRC-licensed Facilities and Sites: Logic, Strategic Approach and Discussion, NUREG/CR-6948, Vol. 1 & 2, prepared for US NRC, November 2001.

Comments: 09-46, 09-53

Summary: EB06 - Comments were made that the discussions in Appendix P need to reflect recent research regarding the effectiveness of composite barriers utilizing clay barriers under a robust high-density polyethylene (HDPE) liner and that older references may not reflect the current state of knowledge. For example, the comment indicates that recent research has shown effective lifetimes for subsurface HPDE liners for hundreds or even thousands of years.

Response: NRC documents are periodically revised as resources allow and to reflect new information as necessary. Recent research has not demonstrated lifetimes for hundreds or thousands of years as HDPE is a modern material. Recent research has estimated or projected based on modeling longer performance of HDPE than stated in the text. The text of NUREG-1757, Volume 2, Rev. 2, is reflecting observations of HDPE, not modeling results. It is possible that HDPE may have long-term performance as an engineered barrier and may provide protection to a buried clay layer to prevent dry-out and cracking. A licensee can provide justification for other ranges of performance than cited in the text based on modeling and observations.

Research over the last decade has been inconclusive regarding long-term cover performance of HDPE. Insufficient information has been provided to support assumed performance lifetimes of hundreds to thousands of years (or even longer timeframes assumed in DOE performance assessments (PAs)). For example, the NRC staff is currently reviewing HDPE and overall engineered cover system performance based on cover systems proposed for the Saltstone Disposal Facility at the Savannah River Site. The NRC staff has potential technical concerns regarding the evidence and arguments presented to support the long-term performance of HDPE and other cover components such as geosynthetic clay liners including lack of consideration of sources of uncertainty with respect to the long-term performance of engineered cover systems/components, lack of model support with representative analog sites, and engineered performance and degradation assumptions. Other potential issues include construction/installation vulnerabilities (temperature, geometry/wrinkling, seams), the assumed number of initial defects, important degradation mechanisms considered, testing methods, and other factors affecting HDPE or assumed HDPE performance that may not have been considered in the most recent DOE PAs (ADAMS Accession Nos. ML19087A176 and ML21287A328)[2]. As additional information is collected and technical issues are resolved, updates to the guidance regarding HDPE and other cover component/system performance will be incorporated in future revisions.

No changes are being proposed to the document to address this comment.

Comments: 09-48

Summary: EB07 - A comment was raised regarding problems with the use of sensors that may provide spurious readings or overstate engineered barrier performance issues if a leak is localized, for example, as well as issues with communication of risk.

Response: The concerns expressed are understood and valid. Ideally, monitoring systems would be designed to provide accurate information and would be reliable. However, some sensors may not be accurate or reliable, especially as they age. When implementing sensors, the licensee should test the sensors that will be employed to understand the likelihood of a false positive (e.g., the sensor alerts that a barrier failed when it did not). The licensee may also want to plan the detection strategy such that they could confirm or verify from a different method information that may be obtained from a sensor. A false positive from a sensor system is less problematic than a release that goes undetected until observed in offsite monitoring.

The response above (minus the first sentence) was added to the text in Section P.3.1, Appendix P, NUREG-1757, Volume 2, Rev. 2, related to sensors.

Comments: 09-49

Summary: EB08 - A concern was raised with statement in Appendix P regarding the long-term performance of compacted clay barriers due to pedogenic processes including wet-dry and freeze-thaw cycling.

Response: The pedogenic changes that were observed are not well-understood but are the subject of continued research. For the cases cited, the clay was buried from approximately one-half to one meter below a natural soil overburden. A more deeply

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[2]E-mail from H. Felsher to D. Ferguson and P. Suggs, *NRC Staff Preliminary Comments on DOE Document, SRRA107772-000009, Rev. 1*, ADAMs Accession No. ML19087A176, U.S. NRC: Rockville, MD. April 2018.

Stuthoff, S., *Technical Report: Performance of HDPE Geomembrane Layers, Composite Barrier Layers, and Lateral Sand Drainage Layers of the 2020 Saltstone Disposal Facility Performance Assessment*, ADAMs Accession No. ML21287A328, Prepared for the U.S. NRC, CNWRA, San Antonio, TX. September 2021.

buried clay layer protected by an HDPE liner should have better longevity. If those types of facilities have been exhumed and examined, that information should be forwarded to the technical staff for inclusion. The point of the text is to emphasize that changes can occur more rapidly than anticipated and there is not a better substitute than observations to understand performance.

No changes were made to the text based on this comment.

Comments: 09-51

Summary: EB09 - A question was raised regarding the need to consider climate change as it may impact hydrometeorological conditions as it related to the calculation of the PMP and PMF.

Response: The NRC staff believes that the approach that uses probable maximum precipitation (PMP) and probable maximum flood (PMF) based off of historical hydrometeorological conditions is sufficiently robust to use for design purposes for foreseeable climate change. The PMP/PMF is an incredibly large event. There has not been an observable increase in PMP/PMF estimates.

With respect to future climate change and hydrologic inputs, many decommissioning assessments are sensitive to the rate of infiltration and the liquid saturation. These parameters typically have rather broad ranges and considerable variability. Climate change is a potential additional source of variability and uncertainty in hydrologic inputs. Many decommissioning sites are associated with short-lived activity such that climate change impacts are not expected to be significant compared to historical variability. For sites with long-lived activity, alternate climate scenarios may be used to understand the sensitivity of results to future climate states.

No change is being made to the text to address this comment.

Comments: 09-52

Summary: EB10 - A request was made for examples of expectations for a long-term surveillance program that monitors erosion and financial assurance for surveillance, repair, and replacement of erosion protection barriers.

Response: A long-term surveillance program that monitors the magnitude and rate of erosion may make use of a variety of techniques and modern technology. Erosion frames, isotopic studies, and digital aerial imagery may be useful to monitor long-term erosion rates. The licensee's monitoring program should be designed considering the projected rates of erosion. The monitoring frequency would likely be annual or much less, and may need to be dynamic based on what is observed.

Surveillance activities are typically included in DOE's Long-term Surveillance Plans (please see DOE's 2012 guidance entitled Guidance for Developing and Implementing the Long-Term Surveillance Plans, for Uranium Mill Tailings Radiation Control Act

(UMTRCA) Title I and Title II Disposal Sites, Section 2.3.3.3). The funding for the long-term surveillance program referenced in list item number 3 for uranium recovery sites, for example, is provided in the Long-term Surveillance Charge (or Fee) that is developed by the DOE and provided to the NRC for review and concurrence (see Section 5 of DOE's 2016 guidance entitled *Process for Transition of Uranium Mill Tailings Radiation Control Act Title II Disposal Sites to the U.S. Department of Energy Office of Legacy Management for Long-Term Surveillance and Maintenance*).

The sentence in P.2.7 was updated as follows:

The staff will work closely with the expected long-term custodian to determine the amount of funding needed and this will be included in the Long-term Care Fee that will be paid by the licensee.

Subject: 12 - Uncertainty Analysis

Comments: 03-13

Summary: UA01 - A comment was raised that a discussion on decision uncertainty is missing from the Decision Framework steps presented in Chapter 1. Given the level of uncertainty, a decision-maker needs to determine whether additional information needs to be collected to reduce uncertainty.

Response: Consideration of parameter uncertainty is mentioned in step 3 and reduction of uncertainties by the collection of more information is mentioned in step 8. Given the importance of considering all sources of uncertainty, modifications were made to the text to emphasize the consideration of uncertainties.

The statement *Uncertainty in conceptual models should be considered* was added to step 3 and the phrase considering uncertainties was added to step 9.

Comments: 03-15

Summary: UA02 - A comment was raised about the treatment of uncertainty in engineered barrier performance and the need to consider an increase in uncertainty in engineered barrier performance over time.

Response: The issue of temporally-varying parameters or inputs can be important but is usually not the source of the sometimes-perceived disconnect between the modeling approaches and the assertion that uncertainties in engineered barrier performance increase with time. Usually, a present-day state is assessed, and then degradation phenomenon are applied. This results in a projection as to when the performance of a barrier may decrease to the point that it is no longer effective. Uncertainties in the rates of degradation can produce large ranges in the 'failure' times of barriers. The impact of that uncertainty gets reflected in the modeling results. What is more difficult to account for is less likely but still plausible FEP sequences that may occur with extended timeframes at least in part as a result of the limited observational database. In other words, the scenario or conceptual part of the modeling development process, if enhanced, is likely to better reflect the perception that uncertainties generally increase with time. It should be noted that one of the major sources of uncertainty is with respect to future human behavior. The NRC staff advocates cautious but reasonable selection of present-day receptor scenarios to encompass a broad range of future human behaviors.

No changes are being made to address this comment.

Comments: 03-21

Summary: UA03 - A comment was made that Figure Q.3 shows an interesting issue regarding the problem of truncation of parameters, which is not addressed in the text.

Response: The comment is noted. However, the example was intended to convey the need to consider the representativeness of sampling that is performed. In the case that Figure Q.3 corresponds to, aspects of temporal and spatial variability are discussed. The probability distribution selected to implement in a model should accurately represent the data. Some parameters will have physical bounds. Those bounds should be preserved in the modeling. The statistics of the values of the distribution used in the assessment should be the best representation of the measured data. In some cases, discrete distributions may be needed as a proper fit of other probability distributions to the observed data may not be achieved. Additional information is provided in Section I.7.4, Appendix I, NUREG-1757, Volume 2, Rev. 2, on parameter distributions for Monte Carlo analysis.

No changes were made to the document to address this comment.

Comments: 03-22

Summary: UA04 - The trend in saturation in Figure Q.3 as inferred from the legend (from low values to high values and back down to low values going from the outer right to the center) was questioned as the trend did not appear to make sense.

Response: Although the commenter is correct that the saturations do not show a consistent pattern in saturation (which might be expected), the intent of the example was simply to show the importance of spatial and temporal scales as part of the sample design and potential issues associated with representativeness of data.

Comments: 03-23

Summary: UA05 - A comment was received about the importance of parameter correlations and functional relationships to help ensure the results of probabilistic performance assessment are sensible. For example, sampling of plant consumption rates for different plant types independently may lead to a situation where the overall plant consumption is significantly over- or under-estimated (and inconsistent with the amount of crops that could be grown in a contaminated area). The comment goes on to provide examples of where non-real material properties could be obtained if known functional relationships in properties are not preserved (e.g., saturation, moisture content and total porosity). The comment recommends use of site-specific data to constrain parameters and use of functional relationships of an unknown parameter to the measured parameters to make the problem more manageable. The comment also recommended use of influence diagrams to help ensure that important interdependencies are captured in the model as the relationship between key state variables and other key parameters and processes can be quite complex.

Response: Parameter correlations and functional relationships between parameters will generally necessitate the use of complex sampling methods. Most decommissioning assessments are simpler and biased towards assumptions and numerical approaches that produce pessimistic results. The issues associated with parameter correlations and how to ensure preservation of correlations in sampled parameters are beyond the scope of this document. On the rare occasion that it would arise in a licensing review NRC would address the issue on a case-by-case basis. Future guidance may be developed to address complex data sampling scenarios associated with parameter correlations.

No changes were made to the document to address this comment.

Comments: 03-24

Summary: UA06 - A comment questioned under what conditions would the mean of the peaks be favored over the peak of the means.

Response: The licensee can use an alternative metric when key sources of uncertainty are epistemic, impact the timing of peak dose and the peak dose is expected to occur sometime within the period of performance. It may be expensive or impractical to collect information to reduce the uncertainty. Thus, a licensee may elect to use an alternative metric.

No changes were made to the document to address this comment.

Comments: 03-25

Summary: UA07 - A suggested approach and example related to consideration of sub-model uncertainty was provided. Issues of parameter versus model uncertainty and model averaging approaches were raised. The comment provided a suggestion for a fourth model of evaluating sub-model uncertainty in Section Q.5.2.4.

Response: Appendix Q, Option 3 encompasses the method recommended. If there is no knowledge or weight supplied to the various submodels then they may be randomly sampled in a probabilistic assessment. However, if a decision must be made based on the results, then associated guidance on epistemic uncertainty and risk dilution should be considered.

No changes were made to the document to address this comment.

Comments: 03-28

Summary: UA08 - A comment was made regarding an example model abstraction technique employed in a site performance assessment. In the example, two process models were run probabilistically, and sensitivity analyses were conducted to determine the most important model parameters. Key outputs (e.g., streamflow and infiltration rates) were determined by interpolating values from lookup tables with stochastic distributions being used for the key inputs (e.g., precipitation) in the probabilistic, site performance assessment.

Response: This is an interesting example that will be considered in future revisions to performance assessment guidance.

No change was made to the document to address this comment.

Comments: 09-08, 09-12, 09-16

Summary: UA09 - Comments were made about calculation and reporting of the mean of the peaks versus the peak of the mean dose metric. A comment suggested that the guidance should focus on the importance of proper selection of parameter distributions, and caution use of overly broad distributions that could lead to risk dilution.

Response: The pertinent text in NUREG-1757, Volume 2, Rev. 2, Sections 2 and 5, makes a licensee aware of a potential technical issue associated with using peak of the mean from a probabilistic analysis. The licensee is not required to report different metrics, but the licensee is required to understand when risk dilution has occurred and make corresponding adjustments. The technical staff is well-versed in identifying risk dilution and guidance has been provided in Appendix I and Q to help licensees avoid risk dilution in their submittals. A licensee cannot benefit from lack of knowledge; a licensee must demonstrate sufficient knowledge to justify the decision.

No change is being made to the document to address this comment.

Subject: 13 - Surface Water and Groundwater Characterization

Comments: 06-30

Summary: GW01 - A comment was made to change the word "contamination" to "residual radioactivity" in Appendix F.

Response: The NRC staff agrees with the comment and replaces contamination with residual radioactivity, as appropriate.

Residual radioactivity is defined in the glossary at the beginning of the volume, and contamination is not. MARSSIM defines contamination as *the presence of residual radioactivity in excess of levels which are acceptable for release of site or facility for unrestricted use*. Usage of contamination is retained where the context intentionally refers to a broad range of contaminant types, such as inclusion of non-radioactive and organic constituents from the power plant that may be indicators of releases. In some cases, the word *contamination* is retained because it is part of a title or reference or is common terminology used by another entity.

Residual radioactivity replaces instances of contamination, as appropriate, in Appendix F, and elsewhere in this NUREG volume.

Comments: 06-31, 06-44, 09-18

Summary: GW02 - A comment was made that RESRAD-OFFSITE allows for an initial groundwater source term as well as other potential modeling approaches contrary to a statement made NUREG-1757, Volume 2, Appendix F, about screening values not considering existing groundwater contamination. A similar comment was made regarding a statement in NUREG-1757, Volume 2, Rev. 2, that RESRAD-ONSITE does not consider existing groundwater contamination. The commenter wanted a change in the text to acknowledge the use of existing groundwater activity concentrations in RESRAD-ONSITE to calculate distribution coefficients. Finally, in response to a statement in NUREG-1757, Volume 2, Rev. 2, about the unavailability of guidance on use of RESRAD-OFFSITE to consider existing groundwater contamination, another comment pointed out guidance on submerged primary contamination found in the RESRAD-OFFSITE User's Manual.

Response: The sentence in Appendix F about screening values not considering existing groundwater contamination is correct. The screening code, DandD, does not consider existing groundwater contamination. Therefore, the capabilities of the RESRAD-ONSITE and -OFFSITE codes have no bearing on the statement for which the comment was provided.

Although NRC staff recognizes that 4 options are available to estimate the leaching rate in RESRAD (or distribution coefficient, which is used to calculate the leaching rate), the input of existing groundwater concentrations after entering the time since material placement, to derive the leach rate for residual radioactivity in soils, is not equivalent to considering existing groundwater residual radioactivity.

The NUREG-1757, Volume 2, Revision 2, reference to "…*guidance on potential use of RESRAD-OFFSITE to consider existing groundwater contamination [which] has not yet been developed"* is referring to *NRC staff* guidance on the use of the RESRAD-OFFSITE tool. Although it is recognized that the User's Manual for RESRAD-OFFSITE contains some information on the description of the submerged primary contamination case, the information in the User's Manual is not sufficiently detailed to allow evaluation of the approach. For example, the NRC staff was expecting to see the equations that would elucidate the impact of the location of the source zone in relation to the water table on rise time and aquifer dilution similar to information provided in Appendix E to the RESRAD-ONSITE 6 User's Manual. ANL has clarified that revisions to the RESRAD-ONSITE User's Manual will be made for version 7.2. NRC staff will work with ANL to ensure it understands how the tool considers source areas below the top of the water table and develop additional guidance on consideration of submerged sources in anticipation of future use of the tool by NRC licensees.

It is also important to note that this new tool available in recent versions of RESRAD-OFFSITE and RESRAD-ONSITE does not consider existing groundwater plumes. Therefore, if significant residual radioactivity is present in groundwater (not associated with the source area), then a separate evaluation of the contributions to groundwater pathway dose from the existing groundwater plume(s) would need to be considered and the cumulative dose associated with soil and groundwater considered in demonstrating compliance with release criteria.

Changes are being made to the text in Section F.10, Appendix F, NUREG-1757, Volume 2, Rev. 2, to clarify that *NRC guidance* has not been developed to evaluate submerged sources and to clarify that the submerged contaminated zone tool is available in recent versions of both RESRAD-ONSITE and RESRAD-OFFSITE. Text was also added that indicates that if existing groundwater plumes are present, that the dose associated with those plumes should be considered.

Comments: 06-32, 06-39, 06-43

Summary: GW03 - Comments were made about monitoring well guidance including the need for guidance on the duration of monitoring, evaluating monitoring well trends, and the termination of monitoring. Another comment indicated that the guidance was too prescriptive.

Response: Several comments addressed metrics for monitoring networks and sampling frequency. Comment 6-39 suggested monitoring metrics be provided for demonstrating compliance metrics in relation to the site conceptual model discussion in Section F.3, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Development of a Site Conceptual Model*. Comment 6-39 suggested monitoring metrics be provided for demonstrating compliance with groundwater site release limits in Section F.5, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Groundwater Characterization*. Comment 6-43, however, suggested the guidance was too prescriptive for monitoring frequencies and methods in Section F.7, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Monitoring and Network Sampling Frequencies*. These opposing comments illustrate the fine line between the utility of guidance that is prescriptive versus that of general concepts. The NRC staff assessed the possibility of more specific metrics to provide guidance for monitoring networks programs. However, development of metrics applicable to all sites is difficult due to site-dependent complexities, properties, and conditions, and their interplay with monitoring network design. Use of dimensionless metrics that consider a site's complexities and residual radioactivity would be needlessly confusing and may still miss some important features and conditions at a site. Accordingly, conceptual guidance is already provided in the text. Examples include suggestions to evaluate time length scales (e.g., seasonal changes) or to utilize statistical trend approaches. An example of a more prescriptive guidance includes the suggestion to place wells near the source, along the travel pathways, and at site boundaries. The NRC staff prefers guidance that allows licensees to incorporate site-specific features and processes and to document the basis for monitoring network design and implementation that meet the objectives of the regulations.

No changes are made to the text.

Comments: 06-33

Summary: GW04 - A comment was made that the term "scale affects" used in a cross-reference to Appendix Q was not found in Appendix Q, and should be deleted.

Response: The NRC staff agrees that a more direct phrase should be used for relating Section F.3, Appendix F, NUREG-1757, Volume 2, Rev. 2, to the information in Appendix Q.

The sentence is accordingly revised to use the term *uncertainty* rather than delete *scale affects*.

Additionally, information on *uncertainty* in model abstraction and alternative conceptual models is provided in Appendix Q.

Comments: 06-34

Summary: GW05 - A comment was made that the words "or suspected of having leaked" be added to a sentence about leaky components being a high potential risk indicator for groundwater contamination.

Response: The NRC staff agrees with the suggestion to add *or suspected*. This addition means that any indication that a leak has occurred is sufficient to be included as a high potential risk indicator for groundwater contamination.

Text revised to include suspected leaks.

- *storage tanks, waste tanks, and/or piping (above or below ground) that held or transported radioactively contaminated fluids and are known <u>or suspected</u> to have leaked.*

Comments: 06-35, 06-41

Summary: GW06 - Clarification was requested regarding need for characterization of offsite areas where normal or authorized effluent releases led to offsite releases.

Response: NEI comments 6-35 and 6-41 requested clarification on cases where normal, or authorized, effluent releases lead to offsite residual radioactivity that may require NRC staff assessment. The activity levels in normal effluent are measured as part of the effluent monitoring program prior to release to offsite locations (i.e., prior to dilution in the receiving body of water). To meet effluent requirements, dose is estimated based on appropriate exposure scenarios per Regulatory Guide 1.109, Rev. 1, including, for example, in river, lake, or ocean sediments. The activity measurements, volume of release, and the dose estimates are provided in annual radioactive effluent release reports. Sampling and analysis associated with the Radiological Environmental Monitoring Program (REMP) is generally sufficient to satisfy environmental assessments of radiological impacts to the site (see objectives of REMP in Regulatory Guide 4.1, Rev. 2) if the sampling location is prudently chosen. Further characterization of sediments in the offsite locations associated with the discharge during decommissioning may not be necessary unless there are indications that radioactivity levels may have increased to significant levels due to some concentrating mechanism. To protect public safety, however, areas where concentrating mechanisms occur may lead to risk-significant levels of residual radioactivity in the soils, sediments, and groundwater (e.g., levels that could lead to exceedances of the dose standards in 10 CFR Part 20, Subpart E; or 10 CFR 20.1301) that may need to be surveyed as provided in 10 CFR 20.1501. NRC licensees have characterized offsite soils and sediments to evaluate the potential risk to members of the public in a number of cases (e.g., ML100120679[3] and ML17006A156[4]).

Clarification added as a footnote in Section F.8, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Surface Water and Sediments*:

The license terms of any authorization for offsite effluent discharges vary and site-specific conditions may change over time. Thus, for example, concentrating mechanisms may be present at some sites and should be considered. In some cases, offsite surveys have been conducted to evaluate the public health and safety risk of accumulated radioactivity in the environment from licensed operations.

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[3] Letter to Thomas Hartline, Director, Safety and Mission Assurance, National Aeronautics and Space Administration, from Keith McConnell, NRC, regarding *Issuance of Amendment No. 14 to Facility License TR-3 and Amendment No. 10 to Facility License No. R-93*, February 1, 2010.

[4] New York State Energy and Research Development Authority, *Radiological Survey and Dose Assessment Report For the Western New York Nuclear Service Center and Off-Site Areas In Follow Up to Aerial Gamma Radiation Survey Conducted in 2014, Rev. 1*, November 18, 2016.

Comments: 06-36

Summary: GW07 - A comment was received that the words "with a potential pathway to the environment" be added to a sentence about accidents and spills where liquid releases to the interior of a building occur and has a medium potential for residual radioactivity in groundwater.

Response: The NRC staff disagrees with the suggested edit. A liquid spill to exterior to a building is in the High Potential indicator, whereas a spill to the interior of a building is in a Middle Potential indicator. The integrity of a building or structure is difficult to demonstrate. In addition, the location and extent of historical spills often may not have been adequately characterized in Historical Site Assessments.

No change is made to the text.

Comments: 06-37

Summary: GW08 - A comment questioned a listing of groundwater constituents or parameters that may be targeted for analysis.

Response: The NRC's NUREG documents only provide guidance for licensees and are not NRC requirements. Section F.5, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Groundwater Characterization*, provides guidance for sites with known or expected contamination that may help address the suggested objectives in the bullets at the beginning of the section. All or some of the typical analytical parameters in the list may help in the understanding of the hydrogeological system, provide support for the site conceptual model, and be useful for estimation of transport characteristics of residual radioactivity. The NRC staff intends the selection of constituents for analysis be site and complexity dependent.

No change is made to the text.

Comments: 06-38

Summary: GW09 - A suggestion was made that NRC add a statement that changes in monitoring well networks do not require prior NRC approval.

Response: The NRC staff understands the request for clarification on the process for making changes to monitoring well networks and expands the discussion to changes to monitoring programs in general. A paragraph is added to the end of Section F.7, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Monitoring Network and Sampling Frequencies*, that describes the NRC staff's intention for providing flexibility and a level of practicality to licensees for addressing evolving monitoring programs. That flexibility does not include aspects of a monitoring program explicitly laid out in the license (e.g., technical specifications, license conditions), changes to which, require NRC staff approval. For other aspects, NRC staff recommends prior notification of or approval for significant changes. The level of significance may be subjective and site-dependent; hence, NRC staff recommends that all changes should be documented (e.g., in annual reports) and informally discussed with the NRC staff. All changes to a monitoring program may be reviewed as part of inspections.

A paragraph is added at the end of Section F.7, Appendix F, NUREG-1757, Volume 2, Rev. 2, as follows:

Licensees have substantial flexibility to modify their monitoring programs for practical and technical purposes. However, some aspects of monitoring programs may be explicitly laid out in the license (e.g., technical specifications or license conditions), changes to which require NRC approval. In addition, all significant changes to a monitoring program should be communicated to NRC staff. Prior discussions with NRC staff are recommended when level of significance is not obvious. Changes to a monitoring program are typically documented (e.g., in annual reports) for later NRC staff review, and help inform inspections.

Further clarifications were added to Section F.2, Appendix F, NUREG-1757, Volume 2, Rev. 2, for situations early in the decommissioning process when evaluation of the efficacy and objectives of groundwater monitoring network should be considered to meet the objectives of decommissioning. The clarifications added to the first paragraph of Section F.2 are as follows:

This planning should take place early in the decommissioning process to facilitate development of the LTP.

…

For sites with groundwater contamination identified prior to beginning decommissioning, existing groundwater monitoring programs may need to be modified to better accomplish the objectives for decommissioning. For decommissioning, the objectives are focused on characterizing the extent and magnitude of residual radioactivity in the groundwater to provide either the (i) input to dose modeling for the development of DCGLs in the LTPs, or (ii) information the licensee needs to determine if remediation may be needed to demonstrate compliance with the decommissioning requirements. An alternative to modifying the groundwater monitoring program to meet the objectives of decommissioning include selection and justification of conservative estimates of residual radioactivity across the site (e.g., modeling).

Comments: 06-40

Summary: GW10 - Clarification of the following sentence in Section F.7 was requested, "The remedial action objective of attaining permitted standards, such as groundwater protection standards, or DCGLs should be demonstrated before monitoring and license are terminated to ensure that the required standards are actually achieved in the long-term…"

Response: The NRC staff agrees the sentence is confusing. The text is accordingly modified for clarity by replacing *permitted standards* with *specified criteria* and *demonstrates* with *identifies* to improve clarity.

The sentence in Section F.7, Appendix F, NUREG-1757, Volume 2, Rev. 2, was changes as follows:

The remedial action objective of attaining specified criteria, (such as groundwater protection standards, or DCGLs) should be identified before monitoring and the license are terminated to ensure that the required standards are actually achieved in the long-term (Pope et al., 2004).

Comments: 06-42

Summary: GW11 - A comment suggested the deletion of the word "quality" in a paragraph in Section F.7 about groundwater elevation measurements.

Response: The NRC staff agrees that surface water and groundwater *quality* could be more explicitly articulated. Rather than just deleting the term *quality*, the text was modified to reflect that concentrations of constituents should be established as part of characterizing the surface water and groundwater.

Text is modified to improve clarity by replacing *quality* with *constituents* as follows:

The licensee should establish concentrations of surface water and groundwater constituents and water levels on a set frequency, based on site-specific considerations.

Comments: 06-45

Summary: GW12 - A comment was made that detailed comparisons between the RESRAD and other groundwater modeling codes is unnecessary and could be replaced with summary description of the codes and a statement that use of the codes requires specific education and training to achieve proficiency in application.

Response: The NRC staff has added an overview of model selection based on a graded approach at the beginning of Section F.10, Appendix F, NUREG-1757, Volume 2, Rev. 2. The graded approach refers to the use of simplified models for less complex sites and contamination, and more sophisticated models for complex sites. This overview better sets up and provides context for the discussion of detailed numerical models for complex sites in Section F.10.1 of Appendix F.

An introductory paragraph was added to Section F.10, Appendix F, NUREG-1757, Volume 2, Rev. 2, to provide context for the use of detailed numerical models at complex sites as follows:

A graded approach may be used for selecting groundwater models to support estimates of dose at a site. As site complexity and magnitude of residual contamination increase, more sophisticated models are recommended. Models with simplified flow and transport approaches may be sufficient for sites with straightforward hydrogeology and source areas, such as the DandD code (NRC, 2001) that uses generic and conservative inputs. As site complexities increase, a code that allows more sophisticated flow and transport equations and site-dependent inputs may be needed, such as RESRAD-ONSITE (Kamboj et al., 2018).

Comments: 07-02, 07-04, 07-05

Summary: GW13 - Comments were raised about the need for language in Appendix F about breaching of confining layers creating contaminant transport pathways due to construction activities.

Response: Several comments suggested changes to the text in Appendix F, *Surface Water and Groundwater Characterization*, related to the awareness of the interaction of construction activities and buried infrastructure with the hydrogeological system. The NRC staff agree that many sites exhibit modification of the natural flow system by buried infrastructure, including instances of breaching of confining layers between previously separate aquifers. The CSM utilized during decommissioning should account for flow system as affected by the buried infrastructure as well as any interactions with decommissioning activities.

Consistent with the suggestions in the Conference of Radiation Control Program Directors (CRCPD) Comments 7-2, 7-4, and 7-5, the NRC staff modified text, as appropriate, in Sections F.3, F.5, and F.7, Appendix F, NUREG-1757, Volume 2, Rev. 2.

The following text was added to Section F.3, Appendix F, NUREG-1757, Volume 2, Rev. 2:

Characterization of the subsurface should also include descriptions of construction activities and buried infrastructure at the site that may have breached confining layers or otherwise modified the natural flow system, thereby modifying transport pathways including creation of pathways between uppermost aquifer and deeper aquifers. Examples of infrastructure that may affect the flow system include building foundations, buried pipes and tunnels, cofferdams, sheet piling, dewatering systems, and any fill material associated with or surrounding the infrastructure.

The following text was added to Section F.5, Appendix F, NUREG-1757, Volume 2, Rev. 2:

The extent of likely breaches in confining layers, such as those caused by construction activities and buried infrastructure, that could provide preferred pathways for the vertical migration of contaminants, should also be depicted in the cross-sections.

The following text was added to Section F.7, Appendix F, NUREG-1757, Volume 2, Rev. 2:

Whereas the uppermost aquifer is generally the prime focus, at some sites it may be necessary to determine both the vertical gradient between the aquifers and the horizontal hydraulic gradient in aquifers below the uppermost aquifer. Flow between aquifers may be due to natural hydrogeological features or to construction activities and buried infrastructure breaching confining layers and providing direct pathways for residual radioactivity to travel to deeper aquifers.

Comments: 07-03

Summary: GW14 - A comment was made that a statement that models showing water pathways and sampling plans during pump and treat and following treatment is needed in the case that pump and treat programs are implemented as part of decommissioning and decontamination activities.

Response: The NRC staff agree with the suggestion to add text on information illustrating pump and treat sampling and transport pathways to Section F.5, Appendix F, NUREG-1757, Volume 2, Rev. 2.

Additional text was added to Section F.5, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Groundwater Characterization*, as follows:

At sites with groundwater remediation, such as pump and treat programs, pre- and post-treatment sampling plans and transport pathways (plan view and cross-section, as appropriate) should be provided.

Comments: 07-06

Summary: GW15 - A comment was made that sampling should not be limited to a stream bank when determining background surface water quality.

Response: The NRC staff agree that *stream bank* can be misleadingly restrictive for guidance. The remainder of the paragraph already describes the intended flexibility for sampling locations. Clarifying text was added to the cited sentence in Appendix Section F.8, Appendix F, NUREG-1757, Volume 2, Rev. 2, *Surface Water and Sediments*, and *bank* was deleted following *stream*.

The following sentence in Section F.8, Appendix F, NUREG-1757, Volume 2, Rev. 2, was edited as follows:

Water should be collected as grab samples from the stream in a well-mixed zone focusing locations in proximity to potential sources or pathways from the facilities.

Comments: 09-35

Summary: GW16 - A comment was submitted that the text likely meant "discharge from groundwater" rather than "discharge from surface water".

Response: The bullet was changed from discharge from surface water to discharge from groundwater.

The bullet was changed to the following:

- *discharge from groundwater*.

Subject: 15 - Definitions

Comments: 03-02

Summary: DE01 - A comment was received regarding the definition of distribution coefficient, which could be broadened or narrowed (to include only K_d) as it means different things depending on its application.

Response: Although the NRC staff agrees the definition could be broadened, the NRC staff is primarily referring to the soil/water partitioning coefficient or K_d in this volume; therefore, this will be made clear in the definition.

The following sentence was added to the end of the definition in the Glossary:

<u>*While there are other types of distribution or partition coefficients such as Henry's law constant (KH) for air/water or the octanol/water coefficient (Kow), only the distribution coefficient or K_d is referenced in this volume*</u>.

Comments: 03-03

Summary: DE02 - A comment was received regarding the definition of exposure pathway, which was contrasted to what is referred to as an environmental or contaminant transport pathway.

Response: The NRC staff reviews are performed on a case-by-case, site-specific basis. Due to varying conditions associated with these reviews, individual exposure pathways (e.g., external gamma, water ingestion, food consumption, etc.) are combined to make up a site-specific exposure scenario (e.g., resident farmer, industrial worker, etc.).

The NRC staff agree that transport pathways are different than exposure pathways. Transport pathways are the processes by which contaminants reach the exposure medium based on specific characteristics (e.g., physical, chemical, hydrological) of the site.

The NRC staff modified the definition of *Exposure Pathways* to the following:

<u>*Exposure pathway. The mechanism in which radioactive material is transferred from the environment to the receptor. Three commonly recognized exposure pathways are inhalation, ingestion, and direct radiation. The combination of individual exposure pathways make up the site-specific exposure scenario*</u>.

The NRC staff also added a definition of *Transport Pathway* to the Glossary …

<u>*Transport pathway. A route by which radioactivity travels through the environment to reach a point that may expose a receptor to radiation exposure, either through ingestion, inhalation, or direct exposure*</u>.

Comments: 03-04

Summary: DE03 - A comment was received regarding the definition of floodplain versus a 100-year floodplain.

Response: The NRC staff agrees with the commenter that the area of the *100-yr floodplain* is a subset and distinct delineation of the more general area of *floodplain.* The second sentence of the definition refers to areas associated with a specific set of flood probabilities, and thus the commenter's inference to the 100-yr return period floodplain. The NRC staff maintains that the second sentence is strictly true - it refers to areas subject to a one percent or greater chance of flooding in a given year, which would be included as part of the more general area encompassed by all flooding.

However, the inclusion of an example to illustrate the concept may be needlessly confusing or misleading because the usage of floodplain in this NUREG is for a generic floodplain.

The NRC staff deleted the second sentence in the definition of a floodplain in the Glossary, but retains the reference to the definition in 10 CFR 72.3 in NRC's regulations.

Comments: 03-05

Summary: DE04 - A comment was received regarding the definition of groundwater including whether the term should be one word or two words and whether the definition including the unsaturated as well as the saturated zone.

Response: The NRC staff is intentionally using *groundwater* in this version of NUREG-1757, Volume 2 to be consistent with usage in NRC regulations as described in 81 *Federal Register* (FR) 86906, dated Dec 2, 2016. Exceptions are found in titles of reports and journal articles in the reference section. The NRC staff also retains the definition of groundwater that includes water in unsaturated and saturated zones.

No changes are being made to the document to address this comment.

Comments: 03-06

Summary: DE05 - A comment was received that the definition of "in-situ recovery" was overly prescriptive including inclusion of steps that seemed to constrain the composition of the lixiviant, the packaging of yellow cake in 55-gallon drums and limit the purpose of uranium recovery for fuel production for use in nuclear power reactors.

Response: The commenter is referring to text which simply describes the process by which industry uses this technology. The description is not a requirement and the NRC staff sees no compelling reason to modify the definition. No change is being made in response to this comment.
No changes are being made to the document to address this comment.

Comments: 03-07

Summary: DE06 - A comment was received that the word "depth" in the definition of transmissivity could be ambiguous and requested that the word "depth" be replaced with the word "thickness".

Response: The NRC staff agrees that *depth*, as used in the definition of transmissivity, could be ambiguous. The definition was modified to use the full *thickness* of the aquifer. The NRC staff follows the U.S. Geological Survey's definition that uses saturated thickness of the aquifer, instead of just saturated thickness

The glossary definition was updated as follows:

Transmissivity. The rate of flow of water through a vertical strip of aquifer that is one unit wide and that extends the full saturated *thickness* *of the aquifer. Transmissivity is the hydraulic conductivity multiplied by the saturated thickness; see definition above for the hydraulic conductivity.*

Comments: 03-08

Summary: DE07 - A request was made for a definition of receptor to be included in the definitions.

Response: A definition of receptor was added to the glossary.

The following definition was added to the glossary:

Receptor. The hypothetical exposed individual for whom the dose received is being assessed. Typically, this would be the average member of the critical group.

Subject: 16 - Restricted Release

Comments: 00-02

Summary: RR01 - Comments were received regarding restricted release requirements including criteria on whether additional removal of residual radioactivity is reasonably achievable. One comment notes that disposal capacity is no longer an issue and that non-radiological risks should be compared to radiological risks.

Response: A number of factors can be considered to determine whether additional removal of residual radioactivity is reasonably achievable, including the factors listed in the text. The importance of the factors may vary based on region and over time, including availability of disposal capacity. The list in Section 3.5, Chapter 3, NUREG-1757, Volume 2, Rev. 2, was not meant to be exhaustive. The NRC staff thinks that overall risk reduction, including consideration of non-radiological impacts, should be considered as part of the decision-making process.

The text was revised as follows: *Licensees should also include other considerations (e.g., distance to the disposal facility, efficient use of available disposal capacity at the offsite facility, unavailability of required treatment options, lack of disposal options other than leaving the contaminated materials on site, and overall risk reduction including non-radiological risks), if applicable and appropriate, in its determination of whether additional removal of residual radioactivity is reasonably achievable*.

Table 2 Crosswalk from Comment ID to Comment

Commenter: 0 Jenny Goodman	**Affiliation: State of New Jersey**

0-0 The New Jersey Department of Environmental Protection (Department) appreciates the opportunity to comment on NUREG-1757 Volume 2. As stated in our review of Volume 1, the Department uses this NUREG extensively and we appreciate the guidance that the NRC staff has provided in these excellent documents. Our views on the Long-Term Control license were delineated in our comment letter on Volume 1. Therefore, they will not be repeated here.

0-1 Section 3.5 Use of Engineered Barriers

The discussion regarding Engineered Barriers is contradictory. The document states that "the assessment of engineered barrier performance should consider reasonably foreseeable, as well as less likely but plausible, disruptive conditions from human activities and from natural events and processes". Later in this section, the NRC states that "for most cover systems, long-term, passive performance is not well understood." There is no engineered barrier that can withstand disruptive conditions from human activities, yet the NRC believes that a site with an engineered barrier can be released for unrestricted use. In New Jersey, unrestricted use release means that there is no need for either institutional or engineering controls. Presumably, the NRC's "unrestricted release" would require some form of institutional control to ensure that future residents are aware of the need to ensure that the engineered barrier remains in place and is not removed completely. Since this requires a restriction, how can the NRC allow unrestricted use if a site employs an engineered barrier?

0-2 In this same section, the document states "licensees should also include other considerations (e.g., distance to disposal facility, efficient use of available disposal capacity at the offsite facility, unavailability of required treatment options, lack of disposal options other than leaving the contaminated materials on site, and the need to use funds to remediate nonradioactive hazards at the same site), if applicable and appropriate, in its determination of whether additional removal of residual radioactivity is reasonably achievable." The Department believes that disposal capacity is no longer an issue, nor is there a lack of disposal options; and that the risk of leaving chemical contamination should be compared to leaving radioactive contamination.

0-3 Section 3.6, Surveying and Considering Risk Associated with Surface and Subsurface Soil

The NRC correctly indicates that the DCGLs derived from dose modeling should be consistent with the actual vertical extent of the residual radioactivity and significant vertical heterogeneity considered. The Department has considered vertical extent of residual radioactivity since 2000, when our remediation standards for radioactive materials were promulgated. The Department urges caution in allowing multiple DCGLs in a single survey unit based on our experience, as this can easily be manipulated to the advantage of the licensee. For example, if there are 4 feet of residual radioactivity and only the first 2 feet are removed, a licensee could then request a higher DCGL because the vertical extent is now only 2 feet. These iterations could lead to unsustainable review requests and a patchwork amount of residual radioactivity remaining. However, because there is merit to modeling depth of contamination, New Jersey has allowed, on occasion, different site specific DCGLs for exceptionally deeper soils (those beyond typical basement construction depths). However, these evaluations should still consider scenarios where this material could be uncovered or brought to the surface by human or natural activities.

0-4 Section 4 Facility Radiation Surveys

Throughout Section 4 on characterization, the NRC should insert the words "vertical and horizontal" before the word "extent".

0-5 4.1.3 Areas of Review

Method 2 allows a licensee to determine characterization survey design, survey unit design, and even DCGL determination without discussing with the regulator. This may lead to expensive remobilization if the NRC does not agree with some of the decisions made by the licensee. Should Method 2 be limited to Group numbers excluded from utilizing screening criteria, such as those involving volumetric or extensive soil or water contamination?

0-6 Section 4.2.2 Characterization Surveys

The NRC lists onsite disposal as a remediation technique. Does this include burial? Onsite burial should not be an option for remediation unless the material meets all remediation standards. Is the NRC suggesting that a licensee can bury material that exceed the remediation standards and place an engineered barrier over it? For the above reasons listed in Section 3.5, the Department opposes deliberate onsite disposal (burial) as a remediation technique.

0-7 Section 4.5.1.1.3 Information to Be Submitted

The Department suggests including the following wording in italics. The measured sample concentrations, including errors and MDCs in units that are comparable to the DCGLs. The Department also suggests that another bullet be inserted as follows: "a demonstration that Equation 8-2 in MARSSIM is satisfied if appropriate".

0-8 Section 4.5.1.2.1 Minimal Technical Review

The Department suggests another bullet be added to the list of items to be reviewed: the results of Equation 8-2 in MARSSIM to ensure that areas of elevated residual radioactivity are not so numerous in the survey unit that the dose criterion is exceeded.

0-9 Section 4.5.1.2.2 Detailed Technical Review

The Department suggests the following revision of this sentence. "The detailed review could include confirming the selection process and location of measurements using survey unit maps or floor plans, checking measurement results from laboratory data sheets with those inserted into tables or figures in the FSSR, using parameters that are specific to the survey methodology, and re-creating the appropriate MARSSIM statistical test results." Numerous errors have been discovered over the years just from translation of data.

0-10 Table 5.1 Comparison and Description of Exposure Scenario Terms Used in this Guidance

The Department suggests including the following wording in italics. "The screening exposure scenario for residual radioactivity on building surfaces is the building occupancy, and the screening exposure scenario for residual radioactivity in surface and/or subsurface soils is the residential farmer."

0-11 5.2 General Approach to Dose Modeling

It is not clear if the NRC considers a scenario where a house is built on a site with residual radioactivity. The example provided in this section at a rural site with surface soil residual radioactivity, only lists two possible exposure groups:

(1) a gardener who grows a small fraction of his or her fruits and vegetables in the soil and

(2) a resident farmer who grows a larger fraction of his or her own food (i.e., the site supplies not only vegetables but also meat and milk). Do these scenarios include exposure received from the remaining contaminated soil around and under a house? For unrestricted use and for all controls fail restricted use, the Department always considers a residence is built on the remediated site.

0-12 The NRC states that Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," issued September 1988 (EPA 520/1-88-020) (EPA, 1988b), which are based primarily on adults, should be used when calculating internal exposures. While age and sex determinations may not be necessary, the Department has allowed licensees to use more updated adult dose conversion factors such as those found in ICRP 72. Care should be taken that a licensee does not pick and choose which DCFs to use, making sure that all DCFs are selected from the same reference for the same site. While the NRC states that only in rare exposure scenarios will a non-adult individual receive a higher dose (i.e., take in more radioactive material) than an adult individual in a similar exposure scenario, it is not always the amount of material that is ingested or inhaled, but the sensitivity, which is represented in the DCF. Unless the NRC has gone through each age and specific nuclide DCF and compared them to those in FG11 and found the parenthetical statement to be true, the Department suggests removing it.

0-13 Section 5.5.2 Evaluation Criteria for Decommissioning Groups 4 – 5, (Unrestricted Release Using Site-Specific Information) and Section 5.5.3, Safety Evaluation Criteria for Decommissioning Group 6 (Restricted Release). The NRC relies on an institutional control (a groundwater classification restriction), to eliminate the groundwater pathway which, stated earlier in the document, should be assumed to fail at time=0. This is a contradiction. The Department agrees that Classification

Exemption Areas are an institutional control that should be assumed to fail. But if such an institutional control fails, the public health and safety can then be impacted through the groundwater pathway.

0-14 The following statement does not make sense considering ICs fail at time zero: "However, it is important to note that in the case that institutional controls are assumed to no longer be in effect, it may be necessary to evaluate the exposure scenarios and pathways eliminated for the case when institutional controls are assumed to be effective." The Department can see no justifiable reason to ignore exposure scenarios and pathways once ICs fail.

0-15 The Department believes that if treatment can be applied to make groundwater potable, that should not justify elimination of the groundwater pathway. The Department agrees that severe limitations on yields would provide sufficient justification to eliminate the groundwater pathway.

0-16 Section 5.5.4 Safety Evaluation Criteria – Decommissioning Group 7 (Alternate Release Criteria)

The guidance states that "an alternative release proposal in accordance with 10 CFR 20.1404 may allow a dose of up to 1.0 mSv/y (100 mrem/y) for baseline conditions (i.e., unrestricted release or restricted release with institutional controls in effect)." However, the regulation states that the 1.0 mSv/y (100 mrem/y) is for all man-made sources combined, other than medical. The NRC considers man-made sources as building and road construction materials, combustible fuels, including gas and coal, X-ray security systems, televisions, fluorescent lamp starters, smoke detectors (americium), luminous watches (tritium), lantern mantles (thorium), tobacco (polonium-210), ophthalmic glass used in eyeglasses, and some ceramics. So, should the guidance specify an alternate dose criterion to be somewhat less than 1.0 mSv/y?

However, for restricted release sites and specifically for the case where ICs are assumed to no longer be in effect, the dose may not exceed the values in 10 CFR 20.1403(e). Furthermore, the other provisions of 10 CFR 20.1403 must also be met.

0-17 I.4.3.1 Screening

Clarify whether NUREG-1757 Vol. 1, Table B.2 "Screening Values (pCi/g) of Common Radionuclides for Soil Surface Contamination Levels" should be adjusted based on the above discussion.

0-18 The referenced Haaker paper could not be located on the NRC website. Please ensure the document is publicly accessible since it is referenced in this guidance document.

From I.8 references: Haaker, R. "Upper Bound for Inhalation Dose from Carbon-14 Vapor and Tritium Vapor," Sandia.

Letter Report, Sandia National Laboratories, June 1999. (ADAMS Accession No. ML13324B130.)

0-19 Appendix N ALARA Analyses

N.1 Introduction

The Department is confused by the following statements: "Issues raised in 72 FR 46102 that pertained to guidance in the previous revision to this volume (Appendix N in NUREG-1757, Vol. 2, Revision 1) are addressed in Revision 2 to this appendix. Issues included guidance on: (i) discounting rates and (ii) monetary value of collective dose averted among others." In 72 FR 46102, the NRC withdrew the 3% and 7% discount rates, as well as Example 3, but in this revision, these discount rates and example remain. Do these amounts conflict with the License Termination Rule, which provide for a 1% real rate? [10 CFR 20.1403(c)(1)] Perhaps an explanation of real rate vs. discount rate should be added to the guidance document. Nevertheless, 3% and 7% seem to be totally inconsistent with current discount rates.

0-20 N.2.2.1 Restricted Release—ALARA with ICs and without

This section states that for subparagraph (e)(2)(i) of 10 CFR 20.1403, the requirement is not simply to reduce to as low as reasonably achievable, but to show that meeting the dose limit in paragraph (e)(1) is not "technically achievable, would be prohibitively expensive, or would result in net public or environmental harm." Further, 10 CFR 20.1403(e)(2) is a regulatory tool to limit the use of the 500 mrem (5 mSv) per year cap, similar to the way that the ALARA requirement in 10 CFR 20.1403(a) limits the use of restricted release. However, there is very little information in this NUREG on how to verify that a reduction in the dose limit is prohibitively expensive.

0-21 N.3 Evaluation of Cost-Benefit ALARA Analyses

This section describes how there may be situations for which a credible monetary value cannot be developed and suggests that qualitative analyses should be evaluated on their merits on a case-by-case basis. There should be some examples spelled out here on what a qualitative analysis should encompass.

0-22 N.3.1 Simplified Method for Cost-Benefit ALARA Analyses

In section N.2.2.1 the NRC states that once the eligibility for restricted release has been established under 10 CFR 20.1403(a), the general ALARA requirement still applies to the other criteria of 10 CFR 20.1403 for restricted release. But under this section, the NRC states that if a licensee has already decided to perform a remediation action, there is no need to analyze whether the action was necessary to meet the ALARA requirement. This is confusing. Do the sections that follow apply to the eligibility determination or to the ALARA analysis after eligibility has been determined?

0-23 N.3.2.1 Collective Dose Averted

The document refers to Section N.2.7 which discusses additional considerations related to groundwater residual radioactivity, however, there is no section N.2.7 in this volume.

0-24 The Department applauds the NRC for including a discussion of intergenerational consequences and lower discount rates for longer lived radionuclides. However, using a 3% or 7% real discount rate in the current financial situation, does not make sense. Rather than have fixed discount rates, the NRC should have a link to a website that calculates a more realistic discount rate.

0-25 In equation N-2, concentration is described as units of activity per unit area for buildings or activity per unit volume for soil. Shouldn't it be activity per unit weight for soil?

0-26 N.3.2.3 Changes in Land Values

The NRC fails to provide adequate guidance in this section, and merely states that it is difficult to quantify. Are there any references available to determine land values of restricted vs. unrestricted property? How would surrounding property values be affected when a site is left with some residual radioactivity? Has NRC considered the loss of local government tax revenue if a property lays fallow with engineered barriers and deed restrictions in place, versus a fully developed property? These are some costs to consider and should be justified based on local property values.

0-27 N.3.3 Calculation of Costs

Is the total cost determination only for additional dose reduction? For example, if a certain amount of material is removed for restricted use and ALARA considerations are used to determine if additional reductions are cost effective, then the mobilization costs would go away, since mobilization has already occurred. Likewise, transportation, accidents, traffic fatalities, worker dose, and the dose to the public should only include the additional costs for a further reduction, correct? This should be made clearer in this section and throughout the discussion. For example, in the calculation of traffic fatalities should the definition of VA= volume of additional waste produced in units of m3 for additional dose reduction. Or does this section apply to the eligibility determination as well? It is confusing.

0-28 Table N.2 Acceptable Parameter Values for Use in ALARA Analyses

Some of these documents are old. Are there federal websites where more current values can be found like workplace accident fatality rate and discount rates?

0-29 N.3.5 Examples of Calculations

In example 1, if one uses a discount rate for the current day (0.25%), the ratio result is 0.05 meaning that the floor should be washed if the average concentration exceeds about 5% of the DCGL, rather than 16% of the DCGL.

0-30 In example 3, for long-lived radionuclides, like Th-232 the discount rate should be zero. The calculation shows that more soil should be removed if the soil concentration is greater than .03 times the DCGL. These examples illustrate how the selection of a discount rate can make a big difference.

0-31 N.3.7 Additional Considerations for Residual Radioactivity in Groundwater

For uranium and radium, there should be a discussion of determining if concentrations are naturally occurring or if a licensee is responsible for radioactivity in groundwater.

0-32 N.6 Demonstration of "Prohibitively Expensive"

The NRC states that values lower than 10 times the value recommended in NUREG-1530 and NUREG/BR-0058 for VAD may be used when remediation actions could otherwise cause the licensee to become financially incapable of safely carrying out decommissioning. However, when a private company is carrying out the decommissioning and will not disclose its financial information, how can it be verified that the entity is financially incapable of safely carrying out decommissioning?

0-33 N.7 Derivation of Main Equations To Calculate ALARA Concentrations for Unrestricted Use

It would make more sense for this section to be first rather than the restricted use and eligibility discussions. This statement should be further explained: "Additional benefits would apply to restricted use cases (see Sections N.2.1 and N.2.2), and these equations would be modified." What additional benefits and which equations?

0-34 As the Department understands the ALARA analysis, the following sentence should be revised: If the benefits of additional remedial actions would exceed the costs, the licensee should take the additional remedial actions to meet the ALARA requirement.

The Department clarified their comment in an email submitted on June 14, 2021, as follows:
The italics didn't carry over from the word document to the pdf, so here is what the comment says. As the Department understands the ALARA analysis, the following sentence should be revised: If the benefits of <u>*additional remedial actions*</u> *would exceed the costs, the licensee should take the* <u>*additional remedial actions*</u> *to meet the ALARA requirement.*

Assuming one has to perform a remediation to meet the DCGLs, the ALARA analysis should determine any benefits of additional remedial actions, not used to determine if initial remedial action should be taken. Some sites try to use the ALARA analysis to justify not performing any remediation at all.

0-35 Units should be included for all variables in equations N-18 to N-29. Also, it would be helpful to work out an example for soil removal.

0-36 Compatibility Determination

As with our comment on NUREG-1757, Volume 1, it is assumed that the Compatibility Category of C means that states that do not require an ALARA analysis, do not allow issuance of a Long-Term Control license, or states that have different definitions of institutional and engineering controls would not be required to abide by the concepts in this guidance document.

Commenter: 2 Ram Bhat **Affiliation: Citizen (MARSSIM WG)**

2-1 I reviewed NUREG-1757 VOL 2 Rev 1 and Rev 2.

Excellent work: Lot of hard work to address the complicated issues.

2-2 Suggestion #1: Addition of YouTube link in all Statistical terms in Rev 2. (Advantages- Three years ago, my toilet was leaking. I bought a Canister toilet flushing valve-new model from Home Depot. I could not fix the valve. The manual was not clear. I called plumber and he told me it would cost 100 to150 dollars. I am frugal. I went to You Tube and understood how to fix the valve then I could fix it within15 minutes).

Khan Academy gives excellent basic concepts of Statistical terms with examples in YouTube. There is a Null Hypothesis: https://www.youtube.com/watch?v=_3_6wjycJdk.

Scenario A and Scenario B of Null Hypothesis which are not found in Khan Academy, then we can request Khan Academy to introduce the concepts. This way a technician in the field as well as regulator scan understand the statistical concept better. Khan Academy You Tubes are excellent to get the concepts of statistical terms in simple language with examples.

2-3 Appendix J: ASSESSMENT STRATEGY FOR BURIED MATERIAL: Geo–statistic is addressed. More examples are needed for surveys, decommissioning plan and FSSs, etc. More common in DoD, as before 1970, the NRC/former U.S. Atomic Energy Commission allowed to bury the radioactive waste in the back side of the facility.

2-4 Referenced NUREG/CR-7021 (A Subsurface Decision Model for Supporting Environmental Compliance). Very useful publication. More actual real situation of DoD buried waste site and the decommissioning of a nuclear power reactor would be helpful.

2-5 Suggestion # 2: Last month, I was a science Fair Judge for Fairfax County and Loudoun county Science Fair. Some students have done outstanding Science Fair projects of using Machine Language and Deep Learning of Artificial Intelligence (AI) on real life situations. Two examples are given below:

One student took hundreds of X ray images of Covid patients. The present system gives 70 to 75 % accuracy. The student used AI and increased the accuracy to 85%. Another student took hundreds of patients of Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) scans which have again 75 % accuracy. The student combined both PET and MRI images and merged and got higher accuracy than 75% using AI.

Request to higher some high school /college students who have proven records of AI for 2 months in summer vacation. Request each student to apply all data of each Decommissioned nuclear power reactor using AI. They will come out with better accuracy within a short time. This gives you the idea about what is the accuracy of Decommissioned of each nuclear power reactor. This may help to proceed with the existing 20 nuclear power reactors undergoing Decommissioning. This may save lot of Money and time.

Commenter: 3 John Tauxe	Affiliation: Neptune

3-1 This is a well-written document, generally. In fact, I have no general comments other than that.

3-2 p. xlvi, definition of "Distribution Coefficient or Kd": The definition provided is specific to a "solid/water distribution coefficient or Kd." Note that there are other similar distribution coefficients that are used in similar analyses, such as an air/water distribution coefficient, KH, or the octanol/water partition coefficient, Kow. All are distribution coefficients. I would suggest that the proposed definition be either more broad to include other distribution coefficients, or be made more specific if referring only to Kd. Also consider adding a definition of the air/water distribution coefficient, KH, also known as the Henry's Law coefficient.

3-3 p. xlvi, definition of Exposure Pathway. It is my understanding that the exposure pathway also includes activities and behaviors of the exposed individual(s), as well as uptake factors into tissues, dose conversion factors, and the like. In my risk analyses, I generally refer to environmental transport pathways as such, or as contaminant transport pathways, to get to an exposure medium, such as soil, water, or air to which a receptor may be exposed. Calculations from the exposure media to dose or risk (everything in the Exposure Scenario) are to me considered the exposure pathway.

3-4 p. xlvii, definition of Floodplain. Two very different examples are included in this definition. Is it both? The second sentence seems to imply that the definition is limited to what is generally called the "100-year floodplain." Is the definition of "floodplain" to be equated to the "100-year floodplain"?

3-5 p. xlvii, definition of Groundwater. It seems that NRC is changing its style for this term to be one word, rather than two (ground water). It retains the definition that groundwater includes both the unsaturated and saturated zones, however, which is consistent with previous NRC definitions. Note that most organizations outside NRC restrict its use to only the saturated zone.

Is the change to "groundwater" intentional?

3-6 p. xlviii, definition of In Situ Recovery. With all these steps included in the definition, it seems to be overly prescriptive. Is the composition of the lixiviant necessary to this definition? Is it really necessary that 55-gallon drums be used? What if the uranium is used for purposes other than nuclear power reactors? Suggest omitting steps (3) and (4), or better yet, avoiding the steps in the definition altogether.

3-7 p. liv, definition of Transmissivity. Replace the word "depth" with "thickness" (of the aquifer).

Depth can sometimes be confused with the depth to the top of the aquifer. Thickness is unambiguous. Further hydrogeologists use the term "saturated thickness." You might add that transmissivity = hydraulic conductivity × saturated thickness.

3-8 Consider adding a definition of a Receptor.

3-9 p. 13, Replacement figure following Table 1.3: It seems that step 9 is the victim of a copy/paste error, since its contents are identical to step 8. Should probably list step 9 in the original figure.

3-10 p. 1-15, 1.4.1: The statement is made that "The iterative approach ... of using existing information for generic screening and using site-specific information as appropriate ... provides assurance that obtaining additional site- specific information is worthwhile, because it ensures that a more realistic dose assessment will generally result in an estimated dose no greater than that estimated using screening." (Emphasis added.) To the contrary, there should be no expectation that making an assessment more site-specific will reduce doses. It will make it more accurate for a given site, however. Generic screenings do not always produce higher doses than site-specific analyses. This statement should be heavily modified or deleted.

3-11 p. 1-16 et seq. §1.4.2: The steps defined here and shown on the accompanying figure are a bit out of order, in comparison to those in the DQO approach (see § 3.2). Rather than starting with amassing available data and seeing what sort of model could be built from them (an outdated approach), the approach should be to start with the question to be answered, and then determining what data are needed to answer that question.

3-12 Step 2 dances around the concept of determining the FEPSs that are relevant at the site to answering the question at hand. Why not invoke that well-known FEPSs analysis outline here?

3-13 A discussion of uncertainty is also missing from these steps. There inevitably comes a time when a decision-maker must assess the degree of confidence s/he has with a result. For example, does the model show that there is a 95% probability that performance objectives will be met, or only 50%? This matter when deciding how to proceed in either making a termination decision or iterating more on the modeling in order to reduce uncertainties. Uncertainties and sensitivity analysis are briefly addressed in the third paragraph on p. 2-2, however.

3-14 p. 2-12 Table 2-2: The disadvantage of the DCGL approach as an ill-posed problem is only hinted at in mentioning the sum-of-fractions problem. It is worse than what is stated and is a fundamental limitation of this approach. It works if there are only a very few contaminants that pose risks, but more than a few and the problem becomes intractable. This is addressed a bit more fully in §2.5.2 but is still a fundamental flaw in the method.

3-15 p. P-1 § P.1.1: The issue of uncertainty in engineered barrier performance increasing with time is very important. This identifies a problem with many modeling paradigms that do not vary input parameters with time. We really must devise methods for allowing uncertainties in general to increase with time without causing issues for the sensitivity analysis.

3-16 Appendix P does not address the role of covers in attenuation of biotic intrusion, or the role of biota in the degradation of cover materials and structure, except briefly on p. P-16. Biotically-induced transport is too often overlooked in PAs, and yet it has been demonstrated to be the most significant contaminant transport pathway at some sites. Much more attention needs to be paid to this critical transport pathway, from FEPSs to contaminant transport modeling.

3-17 In discussing the degradation of engineered covers (e.g., §P.1.4.1), consider using the term "naturalization", rather than "degradation". In some cases, natural processes acting on a cover may actually enhance cover performance, so it is not always "degraded" per se. The term "naturalization" of covers was introduced at the workshop mentioned on

p. P-16, leading to NUREG/CP-0195.

3-18 p. P-19: Consider promoting the section entitled "Potential Levels of Functionality and Uncertainty" in the outline to level §P.1.4.X, rather than having it under "degradation".

3-19 p. P-36, lines 25-29: Indeed it is beneficial to monitor those parameters that are most significant in evaluating cover performance. This is one of the conclusions of NUREG/CR-6948 (especially vol.2), which should be cited here.

3-20 p. P-39-40, Table P.4: The same reference is listed twice, using slightly different names:

National Academy of Sciences (NAS), "Assessment of the Performance of Engineered Waste Containment Barriers," NAS, Washington, D.C., 2007 and National Research Council, NAS, "Assessment of the Performance of Engineered Waste Containment Barriers," 2007. According to their web site (https://www.nap.edu/catalog/11930/assessment-of-the-performanceof-engineered-waste-containment-barriers), the proper reference should be: National Research Council, 2007. Assessment of the Performance of Engineered Waste Containment Barriers. Washington, DC: The National Academies Press. https://doi.org/10.17226/11930.

3-21 p. Q-7, §Q.5.2.1. The example discussed here and shown in figure Q.3 contains an interesting issue that is not addressed in the text: The problem of truncation in stochastic data. Since saturation cannot be physically greater than 1, the plot is truncated (appropriately) at 1. But the distribution that is used to represent this area is not discussed.

There is a statistical problem of how to handle data that are naturally truncated. Should the mean and median reflect the truncation, or should they move smoothly through? In other words, does the truncation itself move the mean and median of a distribution, or does it simply truncate the values? In procedural terms, does the analyst sample from a non-truncated distribution and then set all values >1 to 1 which does not affect the mean and median values from the original distribution), or does one build a truncated distribution (which does move the mean and median)? This is a subtle but sometimes important distinction and is encountered often in PA modeling.

3-22 p. Q-8, Figure Q4: The colors identified in the legend do not seem to make sense with the plot.

For example, the lavender is tied to a saturation of 0-0.15, and adjacent to it is the salmon color, with 0.75 to 0.9,with saturations dropping to a rather dry “hole” in the middle. This does not make sense.

3-23 p. Q-9 et seq. §Q.5.2.2: Comments on the examples: First example, regarding food consumption. This is a good example, and I have yet to see a PA that implements it properly. The idea is to set a value (or better, a distribution) for average daily caloric consumption, and then allocate that consumption among the various food sources, which are also stochastic in amount. In essence, this is an example of the problem of getting several stochastic inputs to sum to 1 (or a value that can be normalized to 1). This is also the issue for something like assigning area coverage by various plant types, so that the areas occupied by different plant types always add up to the overall plant coverage area.

These are instances of a statistical problem that apparently is nontrivial to solve on the fly. In the second example, the corrosion rate and the retardation factors in soil are both a function of pH and water content. They are both likely a function of more things as well, but for the purposes of the example we can assume that these are the most important controlling factors. The solution here is to construct the calculations of corrosion rates and retardation factors to be functions of pH and water content (which will also be uncertain and may be functions of other things, like the infiltration rate), in the model itself. Other modeling parameters may also be a function of pH (and often temperature), such as solubility and diffusion coefficients. Here are more examples that further illustrate the point, as well as hint at the complexity of interactions in these models: Consider the “fact triangle” of porosity, water content, and saturation, all of which have physical limits at 0 and 1. These three parameters are closely tied together, since S = .w × n. If each is specified as a modeling input independently, it is easy to generate nonreal material properties. They MUST be correlated functionally. This can be done, for example, by defining stochastic inputs for porosity and water content, and calculating saturation from them (conditional on physical limits), or alternatively, calculating water content from porosity and saturation. Similarly, consider porosity, bulk density, and particle density. Again, if defined with independent and uncorrelated distributions, nonreal materials are the result. In all such cases, it is best to define those parameters that have actual data (e.g., porosity from a pycnometer and bulk density from mass and volume measurements) and let the third one be a function of those. Note that both of the previous examples involve porosity. In effect, this ties together saturation, water content, bulk density, particle density, and porosity. Further, the retardation from the preceding example is a function of bulk density and water content, R = (Kd × .b) / .w, so that gets tied in. If we consider that plant growth and chemical uptake are also dependent on pH and water content, and that water content is conversely related to plant growth, we see how this all becomes nearly unmanageable. Again, functional relationships are the best approach. Ultimately, the web of physical and chemical properties becomes deeply intertwined, with complex correlations. (An influence diagram showing these interrelationships would be an excellent addition, here.) If these are not accounted for, all calculations that depend on these properties will not reflect reality.

This is one of the serious limitations of using generic data, addressed in the subsequent section of the report.

3-24 p. Q-10, last bullet: It is not clear what constitutes a case where mean of the peaks is favored over peak of the means.

When would this ever be the case?

3-25 p. Q-14, § Q.5.2.4: I would suggest a fourth method to evaluate submodel uncertainty, which has been successfully implemented. This was for the specific submodel of the calculation of air phase tortuosity in porous media. There are a handful of different models in the literature, most of which involve different ratios and power factors for porosity and air content. The implementation was to include all these submodels in the larger model and choose between them using a stochastic switch. This switch could choose among the models in an unweighted or a weighted fashion (as suggested in the third method). In this particular implementation, it was discovered that the choice of air phase tortuosity model was quite significant in the calculation of radon flux at the ground surface. This result prompted a laboratory investigation of the effective diffusivity of radon through site-specific materials. Obviously, the confidence in the site-specific laboratory measurements was much greater than all the mathematical models found in the literature. This resulted in a lower overall uncertainty (and therefore greater confidence) in the radon flux model endpoint.

3-26 p. Q-14, equation in line 39: The concentration of the chloride ion should be expressed using standard chemistry notation as "[Cl-]", not "(Cl-)". Also, italicize a, b, and C, and present generic dimensions L/T for the corrosion rate, rather than specific units.

3-27 p. Q-15, line 6: The quantification of corrosion rates here should be "mils/yr" rather than simply "mils"

3-28 p. Q-16 §Q.5: A much more interesting and complex example of process model abstractions may be found in a recent model by Neptune and Company, Inc., where streamflow rates and infiltration rates were both modeled using the process models SWAT and HYDRUS, respectively. Briefly, each was run probabilistically, and then analyzed using sensitivity analyses to determine the most significant inputs for each model. Many of these are shared, such as precipitation. Lookup tables were constructed for both model outputs, providing streamflow rates and infiltration rates, respectively, for values of inputs (e.g., precipitation) selected from stochastic distributions. The input distributions and lookup tables were combined in the probabilistic site model. For various realizations in the site model, the inputs were sampled, and resulting streamflow and infiltration rates were interpolated from the lookup tables. This produced a functional correlation between precipitation (and other variables), streamflow, and infiltration rates, and the technique was a significant advance in model abstraction methodologies. Neptune could share more about this if there is interest in including it in this NUREG.

3-29 Missing: Measurements of 226Ra concentrations in covers. Radium has the potential to move as diffusion in the water phase, even through a radon barrier.

Since 226Ra is a parent of 222Rn, the decay product can be produced above the radon barrier.

3-30 Terminological errors:

p. P-26, 2: The word “erratics” was changed to “erratic”, but in fact “glacial erratics” is the proper term, unless referring to a single stone.

p. P-35, line 14: Replace “Sandia National Laboratory” with “Sandia National Laboratories”.

p. Q-14, line 41: Change “flux rate” to “flux”. A flux is already a rate. See Stauffer, P.H., Flux Flummoxed: A Proposal for Consistent Usage, Ground Water 44(2) pp. 125-128, 2006, U.S. Department of the Interior: 10.1111/j.1745-6584.2006.00197.x

Commenter: 4 Riley Carey	Affiliation: US ACE

4-1 (Appendix G.6) Does NRC have a position on formulating indistinguishable from background surveys using the Scenario B definitions in MARSAME (Section 4.2.4 and associated references) as opposed to that presented in MARSSIM Rev. 1 and NUREG 1505? Specifically, the MARSAME approach shifts the gray region to consist of an action level as the LBGR (typically zero or background) and a background discrimination level (e.g., a standard deviation multiple, etc.) as the upper bound of the gray region, which does not necessarily require a DCGL. This approach evaluates “site vs accepted extent of background” rather than “site vs a heterogeneous background within a DCGL” and may be more relevant for partial site release prior to a final site characterization (analogous to a Comprehensive Environmental Response, Compensation, and Liability Act removal action) and for situations where a DCGL is not or will never be developed. Additionally, if the upcoming MARSSIM revision adopts this language for consistency with MARSAME, the reference to NUREG 1505 will become outdated.

4-2 (Appendix O) Has NRC considered the use of composite sampling in final statis survey outside of formal statistical testing (i.e., Sign Test, Wilcoxon Rank Sum Test, etc.) with the intent of maximizing sample representativeness and minimizing variance rather than for detection purposes as presented in Appendix O? True population variance is very significant in systematic MARSSIM samples for statistical testing, but the focus of other samples (e.g., biases or characterization samples) may shift to acquiring the best possible representation of mean activity over a defined/bounded area rather than identifying every potential instance of a radionuclide over what may already be assumed heterogeneous.

Examples include 100 square meter areas for UMTRCA and either a well-bounded or pre-defined contiguous elevated measurement comparison area, either of which may be internally heterogeneous. In these cases, characterizing or even detecting local variability is less important than acquiring a reliable approximation of the mean activity for comparison against an established limit over the same area (i.e., over 100 square meters for UMTRCA or a $DCGL_{EMC}$ per a defined area). Table O.1 lists lost spatial variability information as a disadvantage, but in this context that’s actually the incentive. A properly homogenized composite consisting of many increments doesn’t overvalue the influence of any single increment and instead provides a more representative measure of the mean activity over a discrete sampling area than would the mean of discrete samples. While the specifics may differ, this intent is more so consistent with the Interstate Technology and Regulatory Council Incremental Sampling Methodology than that presented in Appendix O.

4-3 (Appendix O) If composite samples have been considered with this intent, has NRC considered method uncertainty requirements as the primary MQO as in MARLAP (Appendix C) and MARSAME (Sections 3.8.1 and 7.3.1) rather than the detection objective captured through the “modified investigation level” in Appendix O? Specifically, in this case, the composite samples are individually answering the question “is the mean activity over this discrete area within some specified limit?” not “has a particular radionuclide been detected in this discrete area?” For this reason, the primary MQO is better suited to support the actual decision by ensuring the sample uncertainty is sufficiently low to allow that decision to be made (i.e., the mean activity is less than the limit) with specified confidence.

Commenter: 5 Lee Gordon	Affiliation: NYSERDA

5-1 New York State Energy Research and Development Authority (NYSERDA) suggests adding clarifying language to Appendix G (see Page G-4, first bullet). Specifically, we propose that in addition to the dose associated with the building structure, system, or component residual radioactivity, the potential dose from residual radioactivity in environmental media should be included in the total dose apportionment calculations to determine if the potential dose from offsite use exposure scenarios exceeds a few hundredths of a millisievert (i.e., few millirem per year).

5-2 With regard to Page G-7, Section G.3.1, we suggest additional language be included here to identify the specific method(s) that the NRC proposes be used to identify the subsurface HTD radionuclides during a radiological survey or through modeling.

5-3 This section also identifies a CCM that supports the conceptual model for a licensed site. NYSERDA is seeking clarity on whether the CCM is submitted by the licensee as part of the MARSSIM process, and whether the CCM is reviewed and approved by the NRC.

5-4 Regarding Page G-25, Section G.7, NYSERDA suggests stream sediments be included in the discussion of residual radioactivity as well as in the process for determining cleanup levels used in the decision criteria for survey design and model integration. Further, NYSERDA suggests additional guidance be provided for determining radioactive contamination levels associated with stream sediment, as MARSSIM does not discuss this environmental media.

5-5 NYSERDA is unable to ascertain the basis for Footnote #6 on Page I-26, which states that "the licensee may eliminate a residential scenario, as construction of a residence in the area of active erosion would not be realistic, given its proximity to surface water and uneven topography." Throughout the northeast region and within the local West Valley community, there are myriad examples of residences built and maintained in areas of active erosion. Often, residences are constructed next to actively eroding features, such as deep gullies and eroding stream channels. It is often the proximity to surface water and the views afforded by uneven topography that homeowners find attractive. As such, it does not seem reasonable to preclude a residential scenario for sites/facilities with erosion features.

5-6 As written on Page N-10, Section N.3.2.2, the NRC directs licensees to account only for those regulatory costs avoided through unrestricted release, and therefore not to account for regulatory costs associated with a restricted-release scenario. Viewing avoided regulatory costs as a benefit makes sense; however, on a complex site that contains long-lived radionuclides, we suggest the NRC include guidance for licensees to account for regulatory costs on restricted sites that may span decades or even centuries.

5-7 NYSERDA appreciates the NRC's work to make NUREG-1757 a more useful guidance document for licensees. We believe this opportunity to provide technical feedback will be helpful in this process.

Commenter: 6 Bruce Montgomery	**Affiliation: NEI**

6-0 The NEI1, on behalf of our members, appreciates the opportunity to provide comments on Draft NUREG-1757, Volume 2, Revision 2, "Consolidated Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria." This draft revision includes significant changes to address advancements and lessons learned in the area of radiological site remediation. The guidance provided in this NUREG will provide an important source of information for the development and implementation of license termination plans, FSSs, and associated reporting. Because this NUREG is written to be applicable to a broad range of facility types and licensees, it is necessarily a large compilation of acceptable processes, methods, standards and criteria. As a positive attribute, the ample use of appendices in this revision helps direct users to technical information that is selectively applicable to the unique situations encountered at a specific site.

In recent years, the license termination process has become increasingly lengthy and burdensome to both license termination applicants and NRC reviewers. To reverse this trend, NEI intends to develop a technical report for use by typical commercial nuclear power plant licensees to guide them through the license termination process, and this revision to NUREG-1757, Volume 2 will be a key source document for that report. In light of that forthcoming effort, NEI has reviewed the NUREG-1757, Volume 2 and offers the attached comments which we believe need to be addressed to improve the efficiency of regulatory activities associated with license termination.

6-1 While Tables 1.1 and 1.2 provide a good overview of applicability, the usefulness of the NUREG could be further improved by including a crosswalk to NUREG-1700, Revision 2, "Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans" so that licensees could readily identify how the many elements addressed in NUREG-1757, Vol. 2, Rev. 2 should be used in developing a license termination plan.

Path Forward: Add a crosswalk between NUREG-1700 and NUREG-1757 to clarify expectations for the content of LTP.

6-2 This revision to the guidance contains a significant quantity of information that is pulled from other, existing technical reports. To simplify NUREG-1757, and to minimize the risk that NUREG-1757 will become dated as these other documents evolve, it is strongly recommended that NUREG-1757 simply reference these other documents. This will also help reduce the amount of technical detail in the report and may even eliminate the need for some appendices.

Path Forward: Eliminate or reduce information duplicated from other technical reports.

6-3 There appears to be a disconnect between the minimum information NRC expects to receive in an LTP, a FSS plan and related reports, and the types and amount of information NRC instructs its reviewers to examine. Taken on face value, it appears that with Revision 2, NRC is seeking considerably more data from licensees than has been deemed necessary by NRC in the past. This increase in the types and volume of information requested does not appear to be warranted on the basis of public safety goals, and may result in further protracted reviews, higher costs, and delays in achieving license termination.

Path Forward: Ensure that the license termination process is risk-informed, and that information required to be submitted by licensees is clearly aligned to the information NRC expects its staff to use during the reviews of LTPs, FSSs, and related reports.

6-4 Some important technical areas that have been the source of uncertainty in regulatory expectations and that have NRC should work with stakeholders to develop practical, risk-informed been the cause of multiple requests for additional information and extended reviews have not been addressed in this revision (e.g., hot particles, excavation surveys/assessments, and use of in-situ gamma spectrometry to address excavations). Instead of deferring these issues to the future, the NRC should work with stakeholders to develop practical, risk-informed solutions to these issues before finalizing this revision.

Path Forward: NRC should work with stakeholders to develop practical, risk-informed solutions to these issues before finalizing this revision. In a few cases, the organization of the report with regard to the portrayal of the flow of work, licensee submittals to NRC and subsequent NRC approvals, does not reflect the sequence of activities that will actually occur during decommissioning.

6-5 2.2, page 6, line 3

In the insert "Cautions on Making Assumptions or Committing to a Methodology," the NRC does not provide any criteria or examples for what types of assumptions or methodologies would need advance discussions with NRC to allow the use of the flexible approaches discussed in this section.

Path forward: Consider providing additional detail (examples and/or criteria) to guide the user in the advisability of advance discussions with NRC on the use of flexible approaches.

06-07 3.3, page 3-5, line 2

Text states: "Ratios should be conservatively selected so that they do not underestimate the potential dose contributions of the insignificant radionuclides (e.g., use of MDCs for undetected radionuclides, and use of the 95th percentile ratios of insignificant to significant radionuclides)." Other approaches that have been approved by NRC staff for establishing these ratios have included:

1. The use of actual reported concentrations (even when less than MDCs) using MARLAP principles, and

2. Using the 75th percentile of radionuclide fractions to represent conservative ratios vs. the 95th percentile.

Path forward: Incorporate alternative approaches that have been approved by NRC staff.

06-08 4.1.2, page 4-4, line 33

The parenthetical qualifier "with subsequent PSR" is not needed since side-by-side surveys may be used for other FSS activities or, the PSR may be delayed for practical reasons.

Path forward: Remove qualifier or provide more explanation why this may exclusively apply.

06-09 4.1.3, page 4-5, lines 11 through 26

This section provides two methods to submit information on the final radiation surveys. The two methods are very similar with little discrimination between them.

Path forward: Provide additional detail to discriminate Method 1 from Method 2, or combine into one method.

06-10 4.2.1, page 4-6, lines 37-38

The statement: "Therefore, the licensee shall perform a scoping survey" is too restrictive.

Path forward: Change "shall" to "should..."

06-11 4.5, page 4-15, lines, 23-24

This opening paragraph offers an opportunity to provide additional clarity on FSS report (FSSR) content.

Path forward: Add as second sentence of paragraph: "As a minimum the FSSR should contain the information outlined in 4.5.1.1.3."

06-12 4.5.1.2, page 4-17, lines 21-22

Second paragraph last sentence: "the NRC reviewer may need to obtain previous NRC–-generated reports on the FSS…"

Path forward: Replace "may need to" with "should"

06-13 4.5.1.2.3, pages 4-18 through 4-20

This section appears to effectively negate the objective stated in 4.5.1.2.2 to establish a risk-informed approach to selecting the number of survey units for detailed review. The section lists almost two dozen factors and examples, that, if any one of which could be attributed to a survey unit, could lead NRC to consider the need for a detailed review. This would appear to have the effect of defaulting the reviewer to performing detailed reviews in many cases when not warranted by the risk significance of the survey unit.

Path forward: Consider incorporating other means to more effectively establish the need for detailed reviews of survey units.

06-14 4.5.1.2.3, Page 4-19 lines 27 – 29

Reference is made to $DCGL_W$. Path forward: Should be $DCGL_W$.

06-15 4.5.1.2.3, Page 4- 20, line 6

Reference is made to using MARSSIM statistical tests when hot particles are present. This document provides no guidance on evaluating data when hot particles are present.

Path forward: Please provide a source of guidance.

06-16 4.5.1.2.4, page 4-20 A few of the questions under "Detailed Review Topics" have questionable value in the decision-making process and appear to be arbitrary:

- Does the licensee's analysis rely on a large number of results expressed at MDA (minimum detectable activity) or MDC values?
- Is there a discernible trend in results within and among survey units (e.g., when comparing survey methods, locations, or media matrices)?
- Are there any assumptions about the variability (variance) of the population?

Path forward: Delete these questions and consider incorporating specific guidance into Appendix D.

For example, criteria based on having a lot of MDC values should not be a trigger for a more detailed review. Rather, this may simply be an indicator of an area with very low residual radioactivity.

06-17 4.5.1.2.4, page 4-21 Line 4

This criterion asks the reviewer to look for data outliers and determine whether their disposition was appropriate but provides no guidance on how to make that determination.

Path forward: Include an acceptable approach for identifying and justifying the removing outliers or delete the criterion (consider incorporating into Appendix D).

06-18 4.5.1.2.4, page 4/21 line 7

Identifies the use analytical tools as a criterion for performing a detailed review.

Path forward: Incorporate guidance for which analytical tools are acceptable (or unacceptable) for use without requiring a detailed review.

06-19 Section 5, General Comment

Survey or modeling considerations for hot particles (or discrete radioactive particles) are not addressed in this section despite being issues faced by decommissioning licensees. These are issues that are expected to continue to challenge licensees in the future.

Path forward: Add descriptions or references to modeling and survey techniques for hot particles that have been successfully implemented by licensees.

06-20 5.2, page 5-6, lines 36-40

"The intake-to-dose conversion factors from Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," issued September 1988 (EPA 520/1-88-020) (EPA, 1988b), which are based primarily on adults, should be used when calculating internal exposures.

Path forward: Allow the use of the most recent dose conversion factors developed/published by EPA, National Council on Radiation Protection and Measurements, or ICRP for effective dose or total effective dose equivalent.

06-21 5.3, page 5-8 (lines 29, 36)

Appendix Q is referenced and is not applicable in most cases. (See comment #56 below).

Path forward: Remove sentences referencing Appendix Q.

06-22 5.5.1, page 5-16, lines 7-19

Regarding "Residual Radioactivity Spatial Variability" the document directs NRC staff to "review the licensee's information on conditions before and those projected after the decommissioning alternative is complete. Based on this information, the NRC should determine whether it is appropriate to assume homogeneity (1) for the whole facility [or for surface soils, areas] or (2) for subsections of the facility when evaluating building surfaces."

This is subjective in that the document does not define how the degree of homogeneity is to be determined. Similar comment on page 5-19, lines 1-7

Path forward: Add clarification on what is homogeneous or heterogeneous.

06-23 6.3.3, page 6-3, line 11

The fourth bullet is written in a manner that is unnecessarily restrictive.

Path forward: Revise to: "…that residual radioactivity distinguishable from background remaining at the site at termination is less than 10% of the dose criteria."

6-24 Appendix A, General Comment

Much of the information in this Appendix appears to have been simply extracted from MARSSIM.

Path forward: Consider whether Appendix A is needed given its redundancy with MARSSIM.

6-25 Appendix B, General Comment

This Appendix provides abbreviated guidance for the application of the MARSSIM alternative approach or the NUREG-1757 alternative approach, however states these “simple approaches” can only be used for Decommissioning Groups 1-3. It would be helpful if power reactor licensees could utilize a simplified approach for activities in relatively “clean” areas of the sites to achieve demolition of such structures prior to approval of the LTP, including guidance for the ability for use of such material as fill material on the site. This is often required for logistical purposes to provide unobstructed areas for safe work conditions. And use of “clean” material as fill on site reduces or eliminates the risk associated with handling and shipping of materials offsite.

Path forward: Consider providing guidance to achieve successful remediation/demolition of “clean” facilities/open land areas (i.e., nonimpacted or Class 3) prior to approval of the LTP so that work is not considered “at risk.” Use of screening values, a standard statistical sampling approach, acceptable approaches for use of clean material as fill for onsite excavations, etc. are examples of guidance that would greatly enhance safety at large decommissioning and decontamination (D&D) projects.

6-26 Appendix C, General Comment

Most of the material in this Appendix is academic and has limited usefulness.

Path forward: Consider whether this Appendix is needed.

6-27 C.2, page C-2, line 34

Not all terms in Equation C-1 are defined. Define all terms.

6-28 C.2, page C-9

Although there are values presented for the critical value terms u1, I1 and u2 presented in Table C.1 on page C-9, those terms are not defined in the Appendix.

Path forward: Define u1, I1 and u2.

6-29 Appendix D, D.4 Based on experience, the NRC has stated via Request for Additional Information (RAIs) that the criteria for quality assurance (QA) acceptance for FSS data was too loosely defined, and the procedure used to perform QC assessments was inadequate for comparing samples with levels of residual radioactivity near MDC. In addition, MARLAP was not a heavy influence on project QAPPs; instead, methods from previous decommissioning projects and experiences were employed. Project managers and licensees should have a primary guidance in MARLAP when it comes to laboratory QA.

Path forward: Include specific language in Appendix D that points to MARLAP Appendix C QC acceptance criteria for comparisons of: (1) on-site analytical results to off-site analytical results, (2) on-site split or duplicate samples to standard samples, and (3) replicate static measurements to standard static measurements.

6-30 Appendix F, General Comment

This Appendix refers to groundwater or surface water "contamination" throughout.

Path forward: Consider replacing "contamination" with "residual radioactivity".

6-31 Section F.1, page F.1, lines 15-18

The statement: "In these cases, unmodified screening derived concentration guideline levels (DCGLs) for soil are inappropriate to use, because the screening levels assume surface water and groundwater are usually based on initially uncontaminated." This assumption is only applicable for RESRAD-ONSITE.

RESRAD-OFFSITE allows for an initial groundwater source term as well as other potential modeling approaches.

Path forward: Reword this section.

6-32 F.3, general. This section provides an extensive discussion of need to develop a CSM but no mention on how to show compliance through monitoring well sample results.

Path forward: Incorporate acceptable compliance metrics such as duration of monitoring period and trend of monitoring well concentrations.

6-33 F.3, page F-3, lines 29-30

"…consideration of scale affects is provided in Appendix Q." Appendix Q does not contain the term "scale affects". Remove sentence.

6-34 F.4, page F-4, lines 6-7

- "storage tanks, waste tanks, and/or piping (above or below ground) that held or transported radioactively contaminated fluids and are known to have leaked" Reword to "…known to have or suspected of having leaked"

6-35 F.4, page F-4, lines 19-21

- "surface water or atmospheric discharge of radioactive effluents including authorized releases and spills (e.g., releases in compliance with 10 CFR Part 20, Appendix B effluent concentrations or spills)"

Path forward: Clarify to state that radioactivity from these types of releases that are located outside the site boundary need not be characterized or need to meet site release limits as they have been accounted for as part of reported site releases.

6-36 F.4, page F-4, lines 24-25

- "an accident or spill on site, where liquid radioactive material was released to the interior of a building."

Path forward: Add "...with a potential pathway to the environment" at the end.

6-37 F.5, general

This section, in addition to analyzing groundwater samples for radioactivity, states that the following parameters be analyzed for: sulfate, chloride, carbonate, alkalinity, nitrate, total dissolved solids, total organic carbon, Eh, pH, calcium, sodium, potassium, iron, and dissolved oxygen.

These additional analyses seem excessive for most sites and may only be necessary for site with very complex hydrogeology and/or elevated levels of soil/groundwater contamination.

Path forward: Clarify that the NRC does not require these additional analyzes.

6-38 F.5, general. This section is silent regarding the need for NRC approval prior to making changes to the monitoring well network.

Path forward: Should add that monitoring well network can be changed without NRC pre-approval.

6-39 F.5, general Similar to the comment on Section F.3 above, this section provides no guidance on how to demonstrate compliance with groundwater site release limits through monitoring well sample results.

Path forward: Should add that compliance with site release limits for groundwater can be shown with monitoring well results that do not show an increasing trend for an 18-month period after all remediation is complete and which includes two high groundwater level seasons.

6-40 F.7, page F10, lines 18-20

"The remedial action objective of attaining permitted standards, such as groundwater protection standards, or DCGLs should be demonstrated before monitoring and the license are terminated to ensure that the required standards are actually achieved in the long-term (Pope et al., 2004)."

Path forward: This is a confusing sentence and should be clarified.

6-41 F.8, page F-12, lines 4-9

This section states that: "For offsite effluent discharges, offsite decommissioning activities are not required by NRC regulations…. State and local entities may require different treatment of offsite areas that are contaminated by normal effluent discharges…. For NRC, however, characterization may be needed to assess environmental impacts as part of the environmental assessment or impact statement. Similarly, groundwater seepage of onsite residual contamination to offsite surface waters must be incorporated into environment assessments or impact statements."

This statement is not clear as to where the characterization data for this assessment is to be collected from.

Path forward: It should be clarified that the NRC does not require characterization of off-site areas due to contamination from the migration in groundwater or surface water as the radioactivity from these releases has been accounted for as part of reported site releases. Additionally, any assessment of future impact to offsite areas due to these migrations can be performed using characterization data from on-site groundwater monitoring wells or onsite surface water bodies.

6-42 F.7, page F-10, line 30

"The licensee should establish surface water and groundwater quality and water levels…" There is no definition of groundwater "quality". In fact, the paragraph is focused on groundwater elevation measurements vs. quality. Remove "quality".

6-43 F.7, pages F-10 and F-11

The guidance in this section regarding frequencies and methods appears to be overly prescriptive.

Path forward: Consider removing prescriptive wording.

06-44 F.10, page F-13, lines 34-35

"RESRAD-ONSITE does not consider existing groundwater contamination and only addresses the potential, future transport of residual radioactivity and contamination of ground and surface water and associated doses." Similar to comment 30 above, although not often used, the RESRAD-OFFSITE code does allow for input of existing groundwater activity concentrations after entering the time since material placement, to derive the distribution coefficients.

Path forward: Recommend deletion of the words: "does not consider existing groundwater contamination and only".

06-45 Appendix F, Section F.10

This section provides a high degree of detail in the descriptions of and comparisons between various codes including RESRAD-ONSITE, RESRAD-OFFSITE, MODFLOW and several others. This level of detail may go beyond what is needed for the user of this guidance. Provide a very high-level description of the analytical codes and capabilities/limitations with a caveat that using these tools generally requires very specific education or training to achieve proficiency in application.

06-46 G.3.1, page G-6, lines 24-27

"The approach laid out in NUREG/CR-7026 (Application of Model Abstraction Techniques to Simulate Transport in Soils) presents one potentially acceptable method that may be used in conjunction with radiological survey data to demonstrate compliance." This section does not define an acceptable sampling density.

Path forward: Add an acceptable sampling density or a method to determine an acceptable sampling density.

06-47 G.3.2.1, page G-9

This section discusses the need for an FSS of an open excavation prior to backfilling but does not provide the requirements for that FSS. The section discusses sampling of the excavation but does not provide a required sample density or method to determine the needed density. Additionally, the section does not mention the use of In-situ gamma spectrometry as a method of assessing the excavations which has been approved in the past for some power plant sites.

Add the required sample density or method to determine the needed density for excavations. Add a discussion of the use of in-situ gamma spectrometry as a method of assessing the excavations and any requirements for such assessments.

06-48 G.3.2.2, page G-13, lines 2-10

This section states, for backfill derived from offsite sources that "to support this assumption of no added residual radioactivity would be to use a two-sample statistical test such as a Scenario B type analysis to show indistinguishability from background, as described in Chapter 13 of NUREG–1505".

For large-scale backfill operations where large volumes of material is brought to the site, it would be impractical to conduct a survey to achieve this criterion.

Path forward: Consider alternative methods for sampling and analysis to demonstrate indistinguishable from background for backfill materials.

06-49 I.6.4.4, page I-88, lines 2-7

"If dose and compliance risk are sensitive to the selection of Kd, it may be necessary to conduct experiments using site materials to provide support for Kd values used in dose modeling. For those isotopes where the Kd does not have a significant impact on the dose assessment based on a sensitivity analysis (i.e., the dose results are not a sensitive to Kd), limited justification will be needed to support selection of the parameter value."

In the past, NRC has approved the use of literature values from the worst-case quartile of the parameter distribution for input parameters that are shown to have a significant impact on dose. The requirement to conduct experiments using actual site materials to determine site-specific Kd values replaces an already conservative methodology and is an unreasonable burden on licensees. For selecting values for dose modeling input parameters that are shown to be sensitive in affecting dose from a particular radionuclide, continue to allow the use of the value from the worst-case quartile of the parameter distribution as the input parameter to a deterministic RESRAD run to determine DCGLs.

6-50 Table I-12, page I-89 Same previous comment

6-51 J.1.1, page J-2, lines 1&2

"If the soil at a site is assumed to be capable of growing crops without significant soil engineering, then plant ingestion should be considered." The decision of whether to include plant ingestion involves many other considerations and not solely on the capability of the soil itself.

Path forward: Consider removing or modifying this condition.

6-52 Figure J.8, page J-11

In the approval of past LTPs, NRC has agreed that this is not a realistic exposure scenario. Even though this section states that the license can argue that this scenario is unreasonable, its presence in the NUREG makes the licensee perform unnecessary and burdensome justifications.

Path forward: Delete this scenario.

06-53 J.3.1, pages J-12 & J-13

This section describes the need to assess the radioactivity content in basement surfaces and volumetrically in basement concrete (if applicable). No guidance is given as to the level of survey needed to perform this assessment.

Path forward: Add guidance on the level of survey needed to assess the contamination on/in building basement concrete.

06-54 Appendix O, General Comment

Section provides some specific direction and examples for implementation – however is quite complex and would require a statistician or other high-level SME for interpretation and compliance (guidance points to “academic” publications). Guidance also includes words of “caution” to the user that appear to point to subjectivity in interpretation which could result in disagreement among implementers and regulators. For example: “The composite sampling is used as a method to increase the probability of elevated area or hot spot detection and to reduce analytical cost. However, this situation would require considerable evaluations performed on a case-by-case basis. As such, this guidance provides only a general scenario and the associated variables. If composite sampling is proposed to alleviate sampling requirements associated with HTD radionuclides, the licensee should contact the NRC early in the process to discuss the acceptability of the proposal.”

Path forward: More simplified and straightforward composite sampling model(s) that could be applied for different scenarios would reduce time required for development, review, and approval of such models and ensure consistency in implementation of NRC guidance.

Otherwise – such an approach would likely be cost prohibitive to most sites/licensees.

06-55 O.3.1.1, page O-5, lines 15-22

The following statement appears to contradict itself: “Composite sampling may be used during characterization or to provide additional FSS survey unit coverage for Class 2 and 3 areas to ensure proper classification of the unit. Because Class 2 and Class 3 survey units should not have residual contaminant concentrations in excess of the $DCGL_W$ when properly classified, under most FSS conditions, there is limited, if any, benefit to composite sampling in properly classified Class 2 or 3 FSS units. Use of composite sampling in these classifications would necessitate application of an MIL that is a fraction of the reclassification investigation level.”

Path forward: Please provide clarification.

06-56 O.3.1.1, page O-5, lines 23-31

“Composite sampling may be used for HTD radionuclides for which an actual MDCSCAN cannot be established (e.g., pure beta or alpha emitter in soil) and there are no surrogate radionuclide relationships available. The composite sampling is used as a method to increase the probability of elevated area or hot spot detection and to reduce analytical cost. However, this situation would require considerable evaluations performed on a case-by-case basis. (emphasis added) As such, this guidance provides only a general scenario and the associated variables.”

Path forward: Provide examples of how composite sampling could be practically applied.

06-57 Appendix Q

This Appendix is a new addition compared to Rev 1. The information contained here is generally not applicable to D&D sites. Rather, it appears applicable to waste disposal sites for long-term assessments. The Appendix should either be removed or defined when the principles that are discussed apply to D&D's. The information contained in the Appendix is mostly 'general considerations' on how model uncertainties should be handled for complex modeling, beyond the considerations of RESRAD probabilistic analysis. Also, this Appendix makes mentions of performing analysis for "thousands" of years whereas 10 CFR 20 Subpart E is limited to 1000 years.

Path forward: Delete Appendix.

Commenter: 7 Karen Tuccillo **Affiliation: CRCPD**

7-1 Appendix A - Implementing the MARSSIM Approach for Conducting Final Radiological Surveys

Page A-6 through A-10, Generic comment on Section A.6 Instrument Selection and Calibration.

The term should is used 15 times. Should is not defined in this document.

Recommend defining should in this section. Suggest providing additional clarification such as or provide additional documentation or methods to validate measurements.

7-2 Appendix F - Surface Water and Groundwater Characterization

Page F-3, Line 4 - Suggest inserting the following sentence after the existing sentence that ends on Line 4: The characterization of the subsurface must include descriptions of construction activities and buried infrastructure at the site that may have breached confining layers, thereby creating contaminant pathways from the uppermost aquifer to deeper aquifers (e.g., building foundations, buried pipes and tunnels, cofferdams, sheet piling, dewatering systems, etc.).

7-3 Page F-5, Generic comment on Section F.5 Groundwater Characterization - Larger sites may have an active pump and treat program for chemicals and/or rad during decommissioning. Models should show water pathway and sampling plans during treatment and post treatment.

7-4 Page F-6, Line 38 - Suggest inserting the following sentence after the word groundwater: The extent of any breaches in confining layers, such as those caused by construction activities and buried infrastructure, that could provide preferred pathways for the vertical migration of contaminants, should also be depicted in the cross-sections.

7-5 Page F-10, Line 37 - Suggest inserting the following sentences after the word units: At some sites it may be necessary to determine the horizontal hydraulic gradient in aquifers below the uppermost aquifer. For example, at sites where confining layers have been disturbed by construction activities and buried infrastructure, providing direct pathways for contaminants to travel to deeper aquifers.

7-6 Page F-12, Line 15 - What is the basis for restricting surface water sampling locations to the stream bank when determining background surface water quality?

Commenter: 8 Travis Deti **Affiliation: Wyoming Mining Association**

8-1 General Comments

Decommissioning and reclamation related to licensed uranium recovery facilities is already adequately regulated via the industry specific regulation listed below:

10 CFR Part 40 Appendix A - Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content.

This regulation is supported by specific NUREGS and regulatory guides including Interim Staff Guidance that include:

[The comment goes on to list a number of documents].

8-2 Buried Materials

Draft NUREG-1757 - Volume 2 - Revision 2 - Consolidated Decommissioning Guidance, Characterization, Survey, and Determination of Radiological Criteria contains Appendix J - Assessment Strategy for Buried www.wyomingmining.org Material. Section J.3.1 Modeling Buried Material using RESRAD discusses the application of RESRAD for evaluation of buried material. The Association would like to point out that the uranium recovery industry in Wyoming has documented experience in modeling buried material using RESRAD. Specifically, the Sweetwater Uranium Project licensed under SUA-1350, which effective October 1, 2018 is under the jurisdiction of the State of Wyoming's Uranium Recovery Program, successfully excavated 233,268 cubic yards of 11(e).2 byproduct material between 2005 and 2006 placing the material in the site's tailings impoundment. The excavation work is thoroughly documented in the Catchment Basin Excavation Completion Report dated May 6, 2008 - ADAMS Accession Nos. ML081580085, ML081580086, ML081710278, and ML081710283.

RESRAD was used to evaluate the backfilled excavation. The RESRAD evaluation can be found in Source Material License No. SUA-1350; Docket No. 04008584 Response to Request for Additional Information (RAI) dated November 19, 2008 dated January 28, 2009 - ADAMS Accession No. ML090400162. The RESRAD evaluation resulted in the release of the excavation in Safety Evaluation Report License Renewal of the Kennecott Uranium Company Sweetwater Uranium Project, Sweetwater County, Wyoming dated February 2018, ADAMS Accession No. ML18052B381 which states: In July 2006, the excavation of the catchment basin was completed, and the licensee submitted its Catchment Basin Excavation Completion Report in 2008 (KUC, 2008). The NRC staff reviewed the Completion Report and requested the licensee to perform a radium benchmark dose calculation (NRC, 2008a). The Completion Report did not provide a radium benchmark dose calculation. The licensee subsequently provided three calculations (KUC, 2009). The first two calculations included the radiation dose for surface and subsurface (i.e., the radium benchmark dose). In the third dose calculation, KUC demonstrated that the dose to a critical group (i.e., residential farmer) standing on the top of the backfilled excavated area is below the radium benchmark dose defined in 10 CFR 40, Appendix A, Criterion 6(6). The NRC staff considered the possible impacts to a critical group due to some future activity (i.e., construction) that may cause soils to be removed from the bottom of the excavation and brought to the surface. Although this scenario is plausible, given the remoteness of the site, its industrial use, and the relatively small size of the excavation surface, the probability that soils will be removed from the excavation area and brought to the surface, thereby affecting the critical group, is very small. Therefore, NRC staff determined that the language in License Condition 9.10 should be revised to reflect remediation of the catchment basin.

This case demonstrates the successful application of RESRAD to the release of a large, backfilled excavation.

Commenter: 9 Jennifer McCloskey	**Affiliation: DOE**

9-1 General

The inclusion of lessons learned and references with examples is helpful for perspective on implementation of the requirements.

9-2 General

There are multiple references to the draft NUREG-2175. DOE believes that such references are inappropriate for a regulatory document because the Commission has directed that significant revisions be made to draft NUREG- 2175.

DOE made a similar comment on the GUIDANCE FOR THE REVIEWS OF PROPOSED DISPOSAL PROCEDURES AND TRANSFERS OF RADIOACTIVE MATERIAL UNDER 10 CFR 20.2002 AND 10 CFR 40.13(A) and in the comment response NRC staff did not remove the citation in that guidance. DOE does not agree with that comment resolution and continues to believe that citing a draft document on which the Commission has directed substantial revisions is not appropriate.

9-3 iv, ABSTRACT, Para. 1, Line 3

Clarify what Scenario B is - Change “implementation of Scenario B” to “implementation of final status survey statistical test Scenario B”.

9-4 viii, Table 2, 5th item under Subject

Change “implementation of Scenario B” to “implementation of final status survey statistical test Scenario B”.

9-5 xxxi, Glossary, Para. 2, Line 9

Change “RESRAD Code” to “RESRAD-ONSITE Code” and add in the discussion “RESRAD code, RESRAD (onsite) and RESRAD-ONSITE in the document all refer to current RESRAD-ONSITE code.” RESRAD code is identified as RESRAD-ONSITE beginning July 2016, with version 7.2.

09-06 2-3, 2.1, 7

The risk-informed approach to site-specific dose modeling for compliance demonstration through allowing for the site-specific selection of risk-significant exposure scenarios, exposure pathways, and critical groups, selection of conceptual models, numerical models, and computer codes incorporating risk-significant elements of a site, as well as expecting site-specific data for the more risk-significant input parameters is an essential addition to the document.

May want to include the required verbiage in the contract documents used to ensure the site-specific data is provided. Noting it is expected may not indicate it is a requirement.

09-07 2-11, 2.6, 2

It is stated that for site-specific analyses, the peak of the mean dose over time (e.g., 1,000 years) may be used to estimate dose for compliance with 10 CFR Part 20 Subpart E. This 1,000-year time period is consistent with requirements of Subpart E and DOE supports the use of a 1,000-year time period for strict compliance with the dose standards.

09-08 2-12, 2.7, Footnote 3

Footnote 3 advises caution when using a peak of the means that is significantly different than the mean of the peaks. This seems to potentially lead to a situation where licensees would be forced to report extreme mean of the peaks results for what will be a very subjective comparison with the peak of the means (e.g., how much difference does staff consider significant?). Any comparison of peak of the means and extreme results reflected by mean of the peaks has the potential to lead to misinterpretation by stakeholders.

It is recommended to not imply a need to calculate and report extreme results like the mean of the peaks. It seems more appropriate to provide guidance on how to identify distributions that may be overly broad that could lead to risk dilution.

09-09 4-19, 4.5.1.2.3, Lines 27 & 29

Change “DCGLW” to “$DCGL_w$”.

09-10 4-20, 4.5.1.2.4, Line 31

Define Type I and Type II errors or reference where they are defined in the document.

09-11 5-6, 5.2, 3

“The intake-to-dose conversion factors from Federal Guidance Report No. 11, “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,” issued September 1988 (EPA 520/1-88-020) (EPA, 1988b), which are based primarily on adults, should be used when calculating internal exposures.”

Is use of EPA 1988b a firm requirement or can licensee’s substitute other more recent internal DCF reference documents? More recent internal DCF are available in DOE’s Derived Concentration Technical Standard (DOE 2011), which are based on ICRP Publication 72 (ICRP 1996).

09-12 5-8, 5.2, 4 If the “mean of the peaks” dose is significantly higher than the “peak of the mean” dose, then “risk dilution” may be an issue in the probabilistic model. As stated in previous comment, mean of the peaks represent extremes and reporting such results could result in misinterpretation of reasonably expected impacts by stakeholders. Recommend focusing guidance on identifying other indicators of risk dilution, such as overly broad ranges for input distributions, rather than implying the need to calculate and report mean of the peaks results.

09-13 5-13, 5.4.2, 1

It is stated that "In rare instances, an exposure scenario involving offsite use of residual radioactivity may be the critical exposure scenario". Does the NRC expect offsite exposure scenarios to be evaluated in the DP and what is NRC's criteria for evaluating offsite exposure scenarios? Offsite use of residual radioactivity may include exposure pathways immediately downstream of a licensee's facility to an exposure pathway associated with a LLW disposal facility located 1,000's of miles from the facility in the western United States.

09-14 5-21, 5.5.2, Line 15

Provide reference for dissolved solids of 30,000 milligrams per liter limit in groundwater use or change this to read as "a licensee may eliminate the use of groundwater for drinking or irrigation because the near surface aquifer has total dissolved solid that exceeds the water quality for drinking or agriculture use".

09-15 5-27, Table 5.2, 1st row left column, 2nd bullet

The NUREG states that residual radioactivity is present in approximately the top 30 cm of soil for screening. DandD code is used for screening analysis and DandD code assumes 15 cm soil thickness in the resident farmer scenario (see Page I-59, Line 8). Explain why 30 cm is used here?

09-16 5-24, 5.5.2, Line 35+

On page 2-11 it is stated that "For site-specific analyses, the peak of the mean dose over time (e.g., 1,000 years) may be used to estimate dose for compliance with 10 CFR Part 20 Subpart E." Thus, it is inconsistent and does not seem appropriate to include mean of the peaks here. The compliance should be based on "peak of the means" and reference to mean of the peaks should be removed. As discussed in other comments, the "mean of the peaks" reflects extremes that could give the wrong impression to stakeholders about reasonably expected impacts.

09-17 E-5, E.6, 3

Document denotes, the surveyor will decide whether the signals represent only the background activity, or whether they represent residual radioactivity more than background. Some factors that may affect the surveyor's performance include the costs associated with various outcomes—e.g., cost of missed residual radioactivity versus cost of incorrectly identifying areas as containing residual radioactivity—and the surveyor's expectation of the likelihood of residual radioactivity being present. For example, if the surveyor believes that the potential for residual radioactivity is very low, as in an unaffected area, then a relatively large signal may be needed for the surveyor to conclude that residual radioactivity is present. NUREG/CR–6364, "Human Performance in Radiological Survey Scanning," issued 21 March 1998, contains a complete discussion of the human factors as they relate to the performance of scan surveys. Is there a universal protocol used to ensure the evaluation is more objective?

09-18 F-13, F.10, Footnote 4 Current footnote:

RESRAD-OFFSITE 3.2 considers sources located below the water table, although guidance on potential use of RESRAD-OFFSITE to consider existing groundwater contamination has not yet been developed. A future revision to this volume may include evaluation of this tool and its efficacy in considering existing residual radioactivity in groundwater. Comment: Section G.5 of the "User's Manual for RESRAD-OFFSITE Code Version 4" has a description of the submerged primary contamination. Sections G.11 through G.14 have the mathematical outline of the formulations to model the submerged primary contamination.

09-19 F-16, F.10.2, Para. 3, Line 31

Current text:

Notable differences between initial simulations run with RESRAD-ONSITE and RESRAD-OFFSITE included travel times to the point of compliance that were attributable to differences in use of porosity in the transport calculations (i.e., effective porosity is used in RESRAD-ONSITE, while total porosity is used in RESRAD-OFFSITE).

Comment: The default expression for retardation factor in the release versions of RESRAD-OFFSITE is the same as the one in RESRAD-ONSITE. The expression for retardation factor used in the prototype version of RESRAD-OFFSITE is available as a user selectable option.

09-20 F-16, F.10.2, Para. 3, Line 35; Also, in I-71, I.5.3.6, Para. 1, Line 1 Current text:

Another noteworthy difference in results was observed for the water-dependent pathways due to accumulation of radioactivity in soil from application of contaminated irrigation water that is considered in RESRAD-OFFSITE but is not considered in RESRAD-ONSITE.

Comment: RESRAD-ONSITE considers accumulation over a single growing season, while RESRAD-OFFSITE models accumulation over multiple years.

09-21 F-16, F.10.2, Footnote 7

Add "-ONSITE" as highlighted in the sentence copied as follows." It is important to note that RESRAD-OFFSITE also has the capability of mimicking the RESRAD-ONSITE code for calculation of doses to an onsite receptor."

09-22 F-17, F.10.2, Para. 3, Line 24

Current text:

Another important difference between the codes tested is related to the calculation of retardation. Because RESRAD-OFFSITE is the only code to consider immobile pore water in the calculation of the retardation factor, the calculated retardation factors can be significantly higher for radionuclides with low retardation factors and if the effective and total porosity are significantly different (e.g., in the Gnanapragasam et al. (2000) study RESRAD-OFFSITE calculated retardation factors are higher by a value of 0.56 (unitless) for all radionuclides due to the difference in total and effective porosity at 0.39 and 0.25, respectively). Differences in retardation factors also have a more significant impact on relatively short-lived10 radionuclides.

Comment: The default expression for retardation factor in the release versions of RESRAD-OFFSITE is the same as the one in RESRAD-ONSITE. The expression for retardation factor used in the prototype version of RESRAD-OFFSITE is available as a user selectable option in the released version.

09-23 G-7, G.3.1, 1

Is NRC expecting that licensees develop a CCM as part of their decommissioning plan submittal? Should this be included in NUREG-1757 Vol 1 Appendix D?

09-24 G-11, G.3.2.1, 1

Sheet pilings would preclude surveys of the walls of the excavation. The excavation would require stepped or sloped sidewalls to allow surveying. Suggest some perspective be added for this situation.

09-25 G-14, G.3.2.2, 1

Are licensees required to submit radioanalytical data for backfill soils used during license termination activities? Does this apply to soil imported from non-impacted offsite sources? Is radioanalytical data for backfill soil expected to be provided as part of the decommissioning plan or FSSR?

09-26 G-14, G.3.2.3, 1

Are soil re-use plans a required deliverable of the decommissioning plan or the FSS process? If a decommissioning plan requirement should re-use plans be referenced in the NUREG-1757 Appendix D decommissioning plan checklist? Do the re-use plans require review and approval from the NRC? Does NRC expect to review characterization and radiological survey plans and results to authorize the re-use of impacted on-site soils?

9-27 H-7, Table H.2

According to Appendix I, DandD is inappropriate for analyzing sites that contain hydrogen H-3 and C-14 in soil (see page I-42 lines 11, 12, and 13). Therefore, suggest either removing H-3 and C-14 from Table H.2 or explaining how the surface soil screening values for H-3 and C-14 were determined.

9-28 I-4, I.2.1, 1st para., Line 4

To be consistent with discussion in Appendix F, use “systems and components” instead of “systems”.

9-29 I-14, I.2.3.2, Footnote 5

Current footnote: When a value of "-1" is input into the field for the contaminated fraction for plant food, and the size of the contaminated zone is equal to or greater than 1,000 m2, RESRAD-ONSITE and RESRAD-OFFSITE assume that 50 percent of the crops consumed by the receptor come from a garden grown in contaminated soil (i.e., no more than 50 percent of the produce comes from the contaminated garden and 2,000 m2 is needed to support 100- percent home grown produce ingestion rates). For areas less than 1,000 m2, RESRAD-ONSITE and RESRAD-OFFSITE linearly scale the consumption rates of contaminated produce down from 50 percent for 1,000 m2 areas to 0 percent for 0 m2 areas.

Comment: -1 flag works as described in the footnote in RESRAD-ONSITE.

Can override this by entering a positive value between 0 and 1 to indicate the fraction of contaminated produce from the site.

RESRAD-OFFSITE does not use the flag as the agricultural field is not constrained to be atop the primary contamination/contaminated zone. Fraction of produce, meat and milk from the contaminated area is a user input.

09-30 I-15, 1.2.3.2, 1

The document notes, that although the geometry and locations of the elevated areas or "hot spots" differ in the "conceptual model" versus the "actual" configuration, the assumed geometry and elevated area location tends to overestimate the dose with the receptor standing directly on top of the hottest contaminated area on the site and in relatively close proximity to the second most contaminated area on site. Depending on the actual size and geometry of the elevated areas being simulated, this method may produce overly conservative results. If less conservative methods are needed to demonstrate compliance, the licensee may propose alternative methods that will require approval by NRC reviewers on a case-by-case basis. Suggest providing further guidance on how this can be achieved.

09-31 I-42, I.4.3.1, Para. 3, Lines 11 -13

"As an example, DandD is inappropriate for analyzing sites that contain hydrogen H-3 and C-14 in soil, because DandD considers only the inhalation dose from particulates in the air and does not consider the loss of H-3 and C-14 from the soil to the air as a gas or vapor." Based on this statement, clarify upfront that DandD screening analysis is not appropriate for H-3 and C-14 and explain how the screening values for H-3 and C-14 were derived. Also see Comment on Page No. H-7.

09-32 I-57, I.5.3.2, Line 14

Use 2003 version of RESRAD-BUILD User's Manual (ANL/EAD/03-1) instead of "ANL/EAD/LD-3" (ANL 1994).

09-33 I-61, I.5.3.6, Lines 7 – 28

This section references old RESRAD-ONSITE and RESRAD-BUILD user's manuals, please update these references with the latest user's manuals.

09-34 I-70, I.5.3.6, Line 29

Suggest delete "CE Yu" between "against RESRAD-ONSIE ("and" "benchmarking of".

09-35 I-71, I.5.3.6, Line 29

Current text: discharge from surface water.

Comment: likely referring to contribution from groundwater.

09-36 I-72, I.5.3.6, Line 16

Current text: Removal processes include dry and wet deposition, as well as radiological decay.

Comment: Ingrowth and decay of short-lived radon progeny during transport in air are modeled.

09-37 I-76, I.6.2.3, 3rd para, Line 30

Delete Tables 6-1 and 6-3 because these tables do not list default behavioral and metabolic parameters.

09-38 I-78, Table I.11, Footnote Line 12

Current text: There is only one ingestion rate in RESRAD-BUILD.

Comment: RESRAD-BUILD has two ingestion rates: receptor indirect and direct ingestion rates (see Table A-6 in NUREG/CR-7627).

Receptor indirect ingestion rate: The rate at which an individual ingests deposited dust after it has transferred to hands, foods, or other items at each receptor location. This parameter is used in one of two ingestion pathways. The other pathway is direct ingestion of the contaminated material. The dose from indirect ingestion could be 0 if the ingestion rate is 0 or the deposition velocity is 0. Unlike the direct ingestion rate, the dose from this pathway might be nonzero when the source of contamination and the receptor points are in different rooms.

Direct ingestion rate: The incidental ingestion rate of contaminated material directly from the source by any receptor in the room. For a volume source, each receptor will ingest the source at a rate determined by the product of the ingestion rate and the amount of contamination in the source at that time. For a point, line, or area source, each receptor will ingest the source at a rate determined by the product of the ingestion rate, the removable fraction, and the amount of contamination in the source at that time.

09-39 I-114, I.8, Line 35

ANL/EAD-4 is the reference for RESRAD Manual as stated on Page I-108, Line 16, not for Yu, C., 1999. Please update this reference.

09-40 I-115, I.8, 3rd para

Line numbers are missing for the last reference. This reference should be moved up in the list of references.

09-41 J-1, J.1.1, Lines 28 – 29

Suggest replacing RESRAD with RESRAD-ONSITE. They are also IN other places in this Appendix, e.g., Section J.3.2, page J-13, Lines 36 and 38, etc.

09-42 J-10, J.2.2

The previous scenarios using a residential basement and well for potential on-site exposures after loss of institutional control (Pages J-4-9) are consistent with inadvertent human intrusion scenarios used for LLW disposal facilities. However, the newly added "large scale excavation of concrete" scenario described on pages J-10-11 is extreme in the context of what is considered for LLW disposal and was not present in the existing NUREG-1757, Vol. 2, Rev 1.

This scenario represents a deliberate, rather than inadvertent, action recognizing that a reinforced concrete structure is present. Excavations deeper than 3 meters were also considered to be too unlikely therefore not included in the original classification calculations for 10 CFR Part 61. Such an action is not consistent with "inadvertent" intrusion, which is assumed to occur when the waste or contaminated material is indistinguishable from soil. Such activities would be expected to involve equipment and workers associated with larger scale projects that would be likely to involve characterization and formal permitting activities (such activities are assumed to not occur for construction of the residential basement and well, although they may also be required).

It is recommended to remove this newly added scenario from Appendix J and remove the new sentence added on Page I-36, starting on line 16 and remove the reference to large-scale excavation on P. J-6 in line 3.

09-43 N-23, N.3.7, 2

Residual radioactivity in a licensee's groundwater or facility may discharge into surface waters that are utilized downstream as a drinking water source. Is there an expectation that collective dose be included in the ALARA calculation when the concentrations of residual radioactivity in these downstream drinking water supplies are, or nearly are, indistinguishable from background? Large collective doses can be achieved by large populations consuming residual radioactivity that is nearly indistinguishable from background.

09-44 L-1, L.3.1, Line 31

This section mentions 30 cm soil thickness as surface soil. This conflicts with DandD code default assumption of 15 cm soil thickness as surface soil. Please clarify or change to 15 cm.

09-45 M-8, M 2.2.2, Lines 1 – 10 and Lines 35 – 36

Pond may also get contamination from soil erosion, water runoff, and direct deposition. Deleting aquatic exposure just based on groundwater (GW) availability at a reasonable depth may not be appropriate in all situations.

09-46 P-3, P.1.1, Lines 14-19; and P-7, P.1.3, Lines 10-23

These discussions need to acknowledge more recent research addressing the potential long-term effectiveness of composite covers utilizing clay barriers under a robust HDPE liner. The text is primarily focused on older cover systems that show solely compacted clay is vulnerable to significant degradation but does not sufficiently address research for cases where clay is present beneath an HDPE liner at depths below freeze-thaw. Recent research has shown effective lifetimes for subsurface HDPE liners of hundreds or even thousands of years, which when underlain by a clay layer provides a very robust infiltration barrier.

09-47 P-5, P.1.2, 3

NUREG-1623 provides guidance for designing erosion protection at uranium mill tailing sites located in arid and semi- arid regions of the western United States. Does the NRC consider the guidance in NUREG-1623 applicable for designing erosion protection for facilities in the humid eastern United States?

09-48 P-8, P.1.3, Line 39+

The use of sensors appears to have some appeal, but a great deal of caution is needed when interpreting the results. The text should include some cautions about potential for spurious readings, the real impact of a sensor detecting a crack at one location on the overall performance of the facility, etc. There is a real potential to obtain results that would suggest a problem to stakeholders, when in fact, the measurement may be spurious, or the barriers can be capable of fulfilling their intended function even with a localized change. It poses real communication problems if a single detection from a sensor is interpreted by stakeholders to imply a failure of the barrier.

09-49 P-15, P.1.4.1, 4

Compacted Clay Barrier

"..laboratory and field studies have shown that compacted clay can develop, even within ten years, distinct soil structures such as aggregates and planes of weakness due to pedogenic processes such as wet-dry and freeze-thaw cycling."

Are these pedogenic changes associated with compacted clay barriers located/exposed at the surface? Need to include some discussion of the potential for these changes with compacted clay barriers that are located at the base of a modern composite, multi-layer cover system where the clay barrier is well beneath the frost line and protected by an HDPE liner? In general, the text seems to over-emphasize historic, problematic designs with no protection of the clay layer and under-emphasizes modern composite cover designs that have features to mitigate these concerns.

09-50 P-16, P.1.4.1, 5

United States not Unites States.

09-51 P-22, P.2.1, 1

The PMP and PMF are calculated from historical site-specific hydrometeorological characteristics, which are likely to change with future climate change. When preparing erosion protection designs for covers and streams in decommissioning plans, is NRC expecting licensees to evaluate the potential changes in hydrometeorological characteristics of their sites that may be associated with future climate change and incorporate these climate change effects in its PMP and PMF calculations? Should future climate change impacts also be incorporated into dose modeling hydrologic input parameters such as precipitation?

09-52 P-26, P.2.7, 1

"…the staff will approve a design that would likely incorporate: (1) covers designed to resist erosion for a stability period exceeding 1,000 years, (2) a long-term surveillance program that monitors the magnitude and rate of erosion, and (3) sufficient funding for the surveillance, repair, and replacement of some of the erosion protection. The staff will work closely with the expected long-term custodian to determine the amount of funding needed."

Do you have examples of the expectations for Items 2 and 3? The current text is rather nebulous without general perspective regarding expectations.

09-53 P-31, P.3

This discussion seems to over-emphasize problems associated with historic cover designs and imply a rather pessimistic view of potential cover performance for modern designs that benefit from lessons learned from these older designs. NUREG/CR-7028 is more than 10 years old now. This discussion should also include more recent research on the durability of HDPE (hundreds to thousands of years) and potential long-term effectiveness of composite covers where the clay is overlain by HDPE to limit potential for drying cycles and exposure to infiltration. It is appropriate to discuss challenges with clay layers in dryer climates, but the potential effectiveness of modern composite designs should also be discussed. As presented, the discussion casts doubt on the effectiveness of cover systems, when in fact, recent research suggests that well designed and constructed composite covers can significantly reduce infiltration for very long times (hundreds to thousands of years).