LA CROSSE BOILING WATER REACTOR

LICENSE TERMINATION PLAN

CHAPTER 6, REVISION 1

COMPLIANCE WITH THE RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION

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LIST OF ACRONYMS AND ABBREVIATIONS

AF	Area Factor
ALARA	As Low As Reasonable Achievable
AMCG	Average Member of the Critical Group
AMSL	Above Mean Sea Level
ANL	Argonne National Laboratory
BcDCGL	Base Case Derived Concentration Guideline Level
BFM	Basement Fill Model
BFM $Insitu_{gw}$	BFM Insitu Groundwater
BFM $Insitu_{ds}$	BFM Insitu Drilling Spoils
bgs	Below Ground Surface
DCGL	Derived Concentration Guideline Level
DPC	Dairyland Power Cooperative
FOV	Field of view of ISOCS measurements
FSS	Final Status Survey
G-3	Genoa-3
GW	Groundwater
HSA	Historical Site Assessment
HTD	Hard-to-Detect
ISFSI	Independent Spent Fuel Storage Installation
ISOCS	*In Situ* Object Counting System
LACBWR	La Crosse Boiling Water Reactor
LSE	LACBWR Site Enclosure
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum Detectable Activity
MDC	Minimal Detectable Concentration
NRC	Nuclear Regulatory Commission
PDF	Probability Density Function
PRCC	Partial Rank Correlation Coefficient
RESRAD	RESidual RADioactive materials
ROC	Radionuclides of Concern
TEDE	Total Effective Dose Equivalent
USACE	U.S. Army Corps of Engineers
WGTV	Waste Gas Tank Vault
WTB	Waste Treatment Building

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6. Compliance with the Radiological Criteria for License Termination

6.1. Site Release Criteria

The site release criteria for the La Crosse Boiling Water Reactor (LACBWR) are the radiological criteria for unrestricted release specified in Title 10, Section 20.1402, of the *Code of Federal Regulations* (10 CFR 20.1402):

- Dose Criterion: The residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/yr, including that from groundwater sources of drinking water; and
- As Low As Reasonably Achievable (ALARA) Criterion: The residual radioactivity has been reduced to levels that are ALARA.

Chapter 4 describes the methods and results for demonstrating compliance with the ALARA Criterion. This Chapter describes the methods for demonstrating compliance with the Dose Criterion.

6.2. General Site Description

This section provides a general description of the geology and hydrogeology at the LACBWR site. Land and groundwater use in the vicinity of site are also described. A detailed description of site geology and hydrogeology is provided in Haley & Aldrich, Inc., *Hydrogeological Investigation Report, La Crosse Boiling Water Reactor, Dairyland Power Cooperative, Genoa Wisconsin* (1).

The LACBWR facility is located 17 miles south of the City of La Crosse and a mile south of the Village of Genoa (population about 800) (see Figure 6-1). The nearest community (three miles to the northwest) is Reno, Minnesota, an unincorporated hamlet of about 300 people located on the west shore of the Mississippi River. The nearest community in Iowa is New Albin (pop. 522), five miles southwest of the plant. Victory, Wisconsin, five miles south of the plant on the east shore, is an unincorporated hamlet of about 80 people. The LACBWR licensed site area is shown in Figure 6-2, with a more detailed view of the facilities inside the LACBWR Site Enclosure (LSE) fence shown in Figure 6-3. See License Termination Plan (LTP) Chapter 2, section 2.1.6.1 for discussion of area classification and survey unit boundaries.

6.2.1. Site Geology

LACBWR is located on the east bank of the Mississippi River in the Wisconsin Driftless section of the Central Lowland Physiographic Province. The local geology of the site is generally described as approximately 15 feet of hydraulic fill overlying 100 to 130 feet of glacial outwash and fluvial deposits. These unconsolidated deposits are underlain by flat lying sandstone and shales of the Dreshbach Group and by dense Precambrian crystalline rocks encountered at approximately 650 feet below the ground surface (bgs).

The primary soil types encountered at the site are:

- 0 to 20 feet bgs. Hydraulic Fill – Fill sands are encountered from approximately 0 to 20 feet bgs and described as light brown to brown, fine to medium sands with occasional fine gravel,
- 20 to 30 feet bgs. Brown to grey, fine to medium fine sands underlie the fill, with an average thickness of 7 to 28 feet,
- 30 to 100 feet bgs. Brown, fine to medium sands that also have zones of coarse sand and fine gravel below the finer sands,
- 100 to 115 feet bgs. Brown fine to medium sand and fine to medium gravels,
- 115 to 135 feet bgs. Brown fine to medium sand with trace silt, occasional zones of gravel.

6.2.2. Site Hydrogeology

Regionally, groundwater flows from the bluff towards the Mississippi River. Closer to the river, it is likely that the groundwater flow direction turns "downstream" as groundwater discharges to the surface water. Groundwater elevation data from eight onsite wells agrees with regional groundwater flow and also shows seasonal variation on upward and downward gradients that are influenced by the river stage.

6.2.3. Area Land Use

The LACBWR facility is located in the far western portion of Vernon County on the east bank of the Mississippi River. Although the site area is 163.5 acres, it is relatively isolated as it is bounded by the Mississippi River to the west, a rail line to the east, U.S. Army Corps of Engineers (USACE) property to the north, and a wildlife and fish refuge to the south.

The 163.5 acre site is comprised of the following:

- the 1.5 acre LACBWR facility,
- the Genoa-3 (G-3) coal-fired, 379 MWe electric power station that was completed in 1969 and is owned and operated by Dairyland Power Cooperative (DPC). The G-3 station is located to the south, adjacent to LACBWR,
- an area south of G-3 where the LACBWR Independent Spent Fuel Storage Installation (ISFSI) is located,
- an approximately 36 acre area surrounding the ISFSI containing the closed coal ash landfill from past operations,
- the land north of the LACBWR plant was the site of the former Genoa-1 (G-1) coal (and later oil) fueled power plant (removed in 1989) which now includes the site switchyard and barge washing area (an approximately 900 m^2 coal ash landfill is also present),
- a parcel of land to the east of Highway 35, across from LACBWR.

The area of the Mississippi River adjacent to the site is used for recreational purposes (boating and fresh water fishing) and commercial barge and ship traffic (e.g. barges of coal are delivered to the G-3 station located south of the LACBWR plant). There is a public boat landing on the

site, located approximately 4,000 feet south of the plant. There is a portion (Pool 9) of the Upper Mississippi River National Wildlife & Fish Refuge just south of the site which has limited access for hunting, fishing and recreational activities. Further south are public land areas and the Genoa National Fish Hatchery.

Lock and Dam No. 8, located on the Mississippi River at mile 679.2, is approximately 0.6 miles north of the site. The dam is a 110 feet wide, 600 feet long lock and dam structure owned and operated by the USACE. This facility also allows public access to an observation platform, open from dawn to dusk during the months of April through November. The State of Wisconsin maintains a highway wayside off State Highway 35 approximately ½ mile north of the LACBWR site, across from Lock and Dam No. 8.

The closest town is Genoa, located approximately 1 mile to the northeast of the site. There are no residences within 2,000 feet of any LACBWR structure.

6.2.4. Area Groundwater Use

There are two water supply wells on the site (Deep Well 3 and Deep Well 4) that were installed in 1963 to 129 feet and 116 feet bgs, respectively. Both wells are located up-gradient from the LSE and are still in use as potable water for LACBWR. Separate groundwater wells supply water to the G-3 plant. Regionally, there are five domestic wells south of the LACBWR site and east of Highway 35.

6.3. Basements, Structures and Piping to Remain after License Termination (End State)

The configuration of the remaining backfilled basements, buried piping, open land areas and above grade buildings at the time of license termination is designated as the "End State."

As indicated in Chapter 3 of this LTP, the Reactor Building and WGTV will be demolished and removed to a depth of at least three feet below grade (which corresponds to an elevation of 636 foot Average Mean Sea Level (AMSL)) and backfilled. See Table 6-1 and Figures 6-4 and 6-5. Figure 6-6 provides a cross-section of the Reactor Building basement below 636 foot elevation. All other LACBWR buildings will be fully removed, including above and below grade portions.

All other impacted LACBWR buildings, structures and components, other than the following structures, will be demolished and removed in their entirety. The impacted above grade structures that will remain are:

- LACBWR Administration building
- LACBWR Crib House
- G-1 Crib House
- Back-up Control Center
- G-3 Crib House
- Transmission Sub-Station Switch House
- Barge Wash Break Room
- Security Station

As seen in Figure 6-2, there are numerous buildings associated with the G-3 coal plant that are outside of the LSE, but within the LACBWR licensed boundary, that will remain intact and functional for G-3 power operations. However, these buildings and adjacent open land areas were not used to support LACBWR operations. The majority of open land areas and buildings outside of the LSE fence are designated as non-impacted. The G-3 Crib House is an exception in that it is classified as impacted due to its location in an impacted soil survey unit. See LTP

Chapters 2 and 5 for additional discussion and justification of the non-impacted classification of areas outside of the LSE.

For the basements that will remain, all systems and components will be removed. The backfilled structures are generally referred to as either basements or structures in this LTP Chapter. For the Reactor Building, the concrete exterior to the steel liner and the liner will remain; all interior concrete will be removed. The WGTV basement is comprised of concrete only. All remaining concrete will be decontaminated as necessary to meet the 10 CFR 20.1402 unrestricted use criteria.

Table 6-1 Basements and Below Ground Structures to Remain in LACBWR End State Ground Surface Elevation is 639 feet AMSL

Basement/Structure	Material remaining	Floor and Wall Surface Area (m^2)	Floor Elevation (feet AMSL)
Reactor Building	Concrete	511.54	612
Waste Gas Tank Vault	Concrete	310.56	621

The End State will also include a limited number of buried pipes, with the majority not associated with contaminated operational systems. The exception is the remaining portion of the Circulating Water Discharge pipe which was used as for liquid effluent discharge as well as circulating water discharge. The buried piping to remain in the LACBWR End State is listed in Table 6-2.

For the purpose of this LTP, buried piping is defined as that contained in soil. Typical commercial power plants also contain piping that penetrates walls or is embedded in concrete. However, the design of the LACBWR plant precludes the need for penetrations or embedded piping and none are present.

The potential for significant surface or subsurface soil contamination at LACBWR is low based on the findings of the Energy*Solutions* Technical Support Document (TSD) RS-TD-313196-003, *La Crosse Boiling Water Reactor Historical Site Assessment* (HSA) (2) and the results of extensive characterization performed in 2014 (see LTP Chapter 2). There are indications of subsurface soil contamination under the Turbine Building based on positive groundwater monitoring results down gradient of suspected broken drain lines. However, GeoProbe samples collected under the Turbine Building in the vicinity of the suspect drain lines did not identify plant-derived radionuclides above background. Additional characterization of the subsurface soil was performed after the Turbine Building foundation was removed and the underlying soil exposed. Very low levels of plant-derived radionuclides were identified.

Table 6-2 Buried Piping to Remain in LACBWR End State

Description of Piping	Quantity	Pipe Elevation (Bottom)
High Pressure Service Water from LACBWR Crib House to G-3[1]	40' of 6" 222' of 8"	627′
Deicing Line	105' of 18"	630.5′
South Storm Drain	630' of 48" 100' of 10"	625.0′ 635.0′
North Storm Drain	435' of 24' 250' of 32"	632 .0′ 626.0′
Remaining Portion of High Pressure Service Water Supply to LACBWR Fire Suppression System	863' of 6"	632.75
Remaining Portion of Low Pressure Service Water Pipe	44' of 16"	632.0
Remaining portion of Circulating Water Intake Pipe	40' of 60"	630.5′
Well Water piping for Well #3[1]	438′ of 3", 115′ of 2", 285′ of 1.5"	well water #3 pipe installed vertically to depth of 129′
Remaining portion of Circulating Water Discharge Pipe[2]	525' of 60" steel pipe	630.5′

Note 1: G-3 service water supply pipe and well water supply pipe considered non-impacted. No FSS will be performed.
Note 2: CW Discharge drops 10' to 620.5' at the outfall.

6.4. Future Land Use Scenario and Average Member of the Critical Group

The "Reasonably Foreseeable Scenario", is defined in NUREG-1757, Volume 2, Revision 1 *Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria* (NUREG-1757), (3), Table 5.1 as a land use scenario that is likely within the next 100 years. The Reasonably Foreseeable Scenario for LACBWR is industrial use.

DPC first acquired land at the site in 1941 to build its first coal-fired generation station, G-1. In 1949 an additional 18.6 acres were acquired for G-1 coal ash disposal. An additional 80.8 acres were acquired in 1962. Finally, an additional 26.8 acres was filled by dredging in 1962-63. The total area owned or controlled by DPC was then, and continues to be, 163.5 acres.

The G-1 plant began operation in 1941 and was decommissioned and dismantled in 1989. LACBWR construction began in 1963, was completed in 1967, and was permanently shut down in 1987. DPC's third plant onsite, G-3, began commercial operation in 1969 and continues operation as a major generation resource to the DPC system. The G-3 plant has been updated to meet current environmental standards and is currently performing a major turbine overhaul. The projected remaining operation life of G-3 is projected to be 20-25 years.

Residential use of the site over the next 100 years appears unlikely. The site is relatively isolated as it is bounded by the Mississippi River to the west, a rail line to the east, USACE property to the north, and a wildlife and fish refuge to the south. There are several small communities nearby that would be more suitable to additional residential development than the DPC site. In

addition, the presence of over 36 acres of closed coal ash landfills further supports the assumption of no foreseeable future residential development. Based on surrounding land use, the conversion of the property to recreational use at some point in the distant future is more likely than residential use.

In summary, the DPC site has been in continuous industrial use for 74 years and DPC has no plans to change the land use in the future. The site contains a transmission station and valuable infrastructure to support the sites future use for power supply after G-3 is decommissioned in 20-25 years. Adjacent land, and a part of the DPC site is currently used for recreational purposes. Finally, there are large tracts of land nearby that would be preferable, and more cost-effective to develop for residential use within at least the next 100 year time period than the conversion of the DPC site from industrial use. Residential land use is therefore categorized as "less likely but plausible" in accordance with NUREG-1757, Table 5.1 definitions. Based on the above discussion of future land use, the Average Member of the Critical Group (AMCG) for the LACBWR dose assessment is the Industrial Worker.

6.5. Dose Model Overview

Dose modeling is performed to demonstrate that residual radioactivity remaining at the time of license termination will not result in a dose to the AMCG (industrial worker) exceeding the 25 mrem/yr criterion. This section provides a general overview of the LACBWR site conceptual model and computational methods for dose assessment.

There are five potential sources of residual radioactivity in the End State that were categorized as follows for the purpose of dose modeling; backfilled basements, soil, buried piping, above grade buildings, and existing groundwater. The majority of residual radioactivity to remain at the time of license termination will be contained in basement concrete. There is no indication that significant soil contamination is currently present at the LACBWR site or will be present in the End State. With the exception of the remaining portion of the Circulating Water Discharge Pipe, the limited buried piping that will remain was not associated with contaminated systems and is expected to contain minimal, if any, contamination. Groundwater exposure factors were calculated to address existing groundwater contamination. The dose from each of the five sources will be summed to demonstrate compliance with the 25 mrem/yr dose criterion.

An overview of the dose assessment methods for the five sources is provided below. Detailed descriptions and results are provided in sections 6.7 to 6.16.

6.5.1. Backfilled Basements

The dose model for backfilled basements to remain below 636 foot elevation (see Table 6-1) is designated as the Basement Fill Model (BFM). The BFM calculates the dose to the AMCG from residual radioactivity remaining in the basements.

The basement End State will be comprised of backfilled concrete structures that are physically altered to a condition that would not realistically allow the remaining structures to be occupied. The BFM conceptual model includes two source term geometries; 1) the Insitu geometry where the concrete remains in the "as-left" configuration at the time of license termination and 2) the Excavation geometry where some or all of the concrete is excavated and brought to the surface.

The results of the BFM dose assessments are expressed as Derived Concentration Guideline Levels (DCGLs) in units of pCi/m^2 for each of the two basements. It cannot be ruled out that a portion of the backfilled structures could be excavated and a portion remain in the ground. Therefore, the final dose for demonstrating compliance will conservatively include the sum of the BFM Insitu and BFM Excavation dose.

6.5.1.1. BFM Insitu Scenario

The BFM Insitu geometry includes two exposure scenarios; 1) exposure to well water containing residual radioactivity as a result of leaching from the backfilled concrete surfaces into the fill material and 2) exposure to drilling spoils that are brought to the surface during the assumed installation of an onsite water supply well. The well water scenario is designated as BFM Insitu Groundwater (BFM Insitu$_{gw}$). The drilling spoils scenario is designated as BFM Insitu Drilling Spoils (BFM Insitu$_{ds}$).

The conceptual model for the BFM Insitu$_{gw}$ scenario assumes that the residual radioactivity in floors and walls is released to adjacent fill through leaching into water that comes into contact with the concrete surfaces after backfill. The scenario assumes that 100% of the residual radioactivity is released instantly into the fill which is then treated as contaminated soil. The release occurs immediately after license termination taking no credit for radioactive decay. A water supply well is assumed to be installed adjacent to the down gradient edge of the building and flow to the well is conservatively modeled assuming that structures are not present. Because a clean cover of at least 3 feet is present over potentially contaminated surfaces the dose from direct exposure and soil ingestion/inhalation is negligible or zero. The BFM Insitu$_{gw}$ exposure pathway to the industrial worker AMCG is drinking water from the onsite well.

The BFM Insitu$_{ds}$ scenario assumes that the drilling spoils from the installation of the onsite well are brought to the surface. The well installation is assumed to occur immediately after license termination, before any leaching from concrete occurs and taking no credit for radioactive decay. The residual radioactivity in the floor concrete that is contacted by the borehole during installation is assumed to be inadvertently mixed with the fill material above the floor surface, brought to the ground surface, and spread over a 15 cm thick layer. The BFM Insitu$_{ds}$ exposure pathways are the same as those that apply to contaminated surface soil.

The BFM Insitu$_{gw}$ dose assessment is implemented using the RESidual RADioactive materials (RESRAD) v7.0 model. The BFM Insitu$_{ds}$ dose assessment is implemented using Excel spreadsheet calculations coupled with RESRAD modeling. The results of the BFM Insitu dose assessments are expressed as DCGLs in units of pCi/m^2 for each basement. (see Table 6-1). The concentrations of residual radioactivity (in units of pCi/m^2) at the time of license termination, as determined by the FSS, will be divided by the BFM DCGLs for each Radionuclide of Concern (ROC), and summed as necessary, to demonstrate compliance with the 25 mrem/yr dose criterion.

6.5.1.2. BFM Excavation Scenario

The BFM Excavation scenario assumes that some or all of the backfilled structure concrete is excavated and spread on the ground surface at some time after license termination. For conservatism, the excavation is assumed to occur immediately after license termination taking no

credit for radioactive decay. The residual radioactivity remaining in the backfilled basements is assumed to inadvertently mix with the mass of structural concrete removed during excavation which is generally consistent with the guidance in NUREG-1757, Appendix J, for addressing subsurface contamination. The calculation is performed using Excel spreadsheet and results in BFM Excavation DCGLs that are expressed in the same units as the DCGLs for the BFM Insitu scenario, i.e., pCi/m^2. The fundamental driver of the BFM Excavation DCGL calculation is that the average concentration in the excavated concrete is limited such that the surface soil DCGLs are not exceeded.

BFM Excavation DCGLs were calculated separately for the Reactor Building and WGTV consistent with the BFM Insitu DCGL calculations.

6.5.2. Soil

Derived Concentration Guideline Levels, in units of pCi/g, were developed for residual radioactivity in surface soils that correspond to the 25 mrem/yr dose criterion. RESRAD was used to perform the calculation.

Surface soil is defined as the first 15 cm layer of soil and FSS for surface soil will be performed on the first 15 cm. However, for conservatism, and to ensure efficient implantation of FSS, the surface soil dose assessment assumed a depth of 1 m from the surface. A standard surface soil contamination thickness of 15 cm would result in lower dose (i.e., higher DCGL). In the unlikely event that soil contamination is identified at LACBWR with a thickness greater than 15 cm, additional dose modeling may be required if the conceptual model assumed a 15 cm contamination thickness. Using a 1 m thickness reduces the potential for delays or unnecessary remediation if contamination with a thickness somewhat greater than 15 cm is encountered. There is low potential for significant subsurface contamination to remain in the End State with a geometry comprised of a clean soil layer over a contaminated soil layer at depth.

In the unlikely event that geometries are encountered during continuing characterization or during FSS that are not bounded by the assumed 1 m soil contamination thickness, the discovered geometries will be addressed by additional modeling. The U.S. Nuclear Regulatory Commission (NRC) will be notified if additional modeling is required.

Standard methods for RESRAD parameter selection and uncertainty analysis are used consistent with guidance in NUREG-1757. The AMCG for soil is the Industrial Worker.

6.5.3. Buried Piping

With the exception of the portion of the Circulating Water Discharge Pipe, none of the buried piping to remain at LACBWR was associated with contaminated systems and therefore contamination potential is minimal (see Table 6-2). A buried piping dose assessment was conducted to develop DCGLs for pipe. There is no embedded piping present at LACBWR (i.e., embedded in concrete).

The conceptual model for the buried piping dose assessment is similar to the BFM and includes two scenarios: Insitu and Excavation. In the Insitu scenario the residual radioactivity on the internal surfaces of the pipe is assumed to instantaneously release and mix with a thin 2.54 cm layer of soil in an area equal to the internal surface area of the pipe. For the Excavation scenario, the soil mixing layer is 15 cm due to the extensive ground surface disturbance associated with

the pipe excavation. The Insitu scenario assumes that the released radioactivity is in a below ground, 2.54 cm layer, of soil with no credit taken for the presence of the pipe to reduce environmental transport and migration. This is a conservative assumption, particularly for the Circulating Water Discharge Pipe which will be filled with a flowable fill material. The Excavation scenario assumes that the pipe is excavated followed by instant release of all radioactivity into a 15 cm layer of soil on the ground surface with no cover. The Industrial Worker is exposed to the Insitu and Excavated soil via the same pathways applicable to the BFM and soil dose assessment scenarios. RESRAD modeling is used in conjunction with Excel spreadsheet to calculate DCGLs in units of dpm/100 cm^2.

6.5.4. Existing Groundwater

Groundwater monitoring has been and will continue to be conducted. The final monitoring date will depend on the evaluation of sampling results. Low concentrations of groundwater contamination have been identified adjacent to the suspected broken floor drains under the Turbine Building. Groundwater sampling in 1983 from a well located down gradient of the Turbine Building identified contamination at relatively low concentrations. In late 2012, five additional monitoring well pairs were installed to support site characterization and license termination. Results indicated lower groundwater contamination levels than found in 1983, predominantly H-3. See LTP Chapter 2, section 2.3.7 for a summary of groundwater sampling results prior to submittal of LACBWR LTP Revision 0. In December 2017, the analysis identified elevated H-3 with a maximum concentration of 24,200 pCi/L identified in February 2018 (well MW-203A). A subsequent sample from well MW-203A, collected in April 2018, contained lower H-3 concentrations of 12,100 pCi/L indicating a downward trend. An investigation is ongoing to identify the source of the contamination and the extent of contaminant migration. A report of the investigation results will be provided to NRC for evaluation.

Groundwater exposure factors in units of mrem/yr per pCi/L groundwater concentration are provided to perform dose assessment for existing groundwater contamination.

6.5.5. Remaining Above Grade Buildings

As indicated in Chapters 3 and 5 of this LTP, all impacted LACBWR buildings, structures and components, other than the following structures, will be demolished and removed to a depth of at least 3 feet below grade or removed in their entirety. The impacted above grade structures that will remain are;

- LACBWR Administration building
- G-3 Crib House
- LACBWR Crib House
- Transmission Sub-Station Switch House
- G-1 Crib House
- Barge Wash Break Room
- Back-up Control Center
- Security Station

None of the buildings and structures associated with the Genoa 3 Fossil Station (G-3) are expected to be radiologically impacted. Therefore, the structures associated with G-3 will

remain intact and functional for G-3 power operations. The G-3 Crib House is classified as impacted due to its location in an impacted soil survey unit. The impacted above grade structures that will remain are not expected to contain residual radioactivity and will be subjected to FSS.

The Screening Values in NUREG-1757, Table H-1 will be applied to the FSS of above grade buildings.

6.5.6. Dose Summation for Compliance

The DCGLs for each ROC, in each medium, represent the concentration that would result in a dose of 25 mrem/yr for that ROC and medium independently after adjusting for the dose from insignificant contributor radionuclides. Compliance is demonstrated through the summation of the dose from each of the ROCs in each of the five media (basement concrete, soil, buried pipe above grade buildings and existing groundwater). The LACBWR basements do not contain embedded pipes or penetrations.

To ensure that the dose summation from the residual radioactivity in each of the five media is 25 mrem/yr or less after all FSS is completed, the DCGLs for each medium are reduced based on an assigned, or *a priori*, fraction of the 25 mrem/yr dose criterion. The reduced DCGLs are designated as "Operational DCGLs". The summation of the dose from all ROC, in all five media will equal 25 mrem/yr if residual radioactivity is present at the Operational DCGL concentrations.

A detailed description of the methods and equations used to calculate the Operational DCGLs and perform the compliance dose summation is provided in Energy Solutions TSD LC-FS-TSD-002, *Operational Derived Concentration Guideline Levels for Final Status Survey*, Revision 0 (4). Additional discussion of the compliance dose summation is provided in section 6.22.

6.5.7. Alternate Scenarios

As discussed in section 6.4, the industrial use scenario was selected as a "reasonably foreseeable" scenario based on past and projected use of the LACBWR site. Two alternate land use scenarios were considered including recreational use, and residential use with a water supply well and onsite garden.

A qualitative evaluation of a recreational land use scenario concluded that the dose would be lower than that calculated for the industrial use scenario because occupancy time would be less than that assigned to an industrial worker. In addition, if a water supply well were installed in the recreational land use scenario, the recreational user's intake rate from the well would be less than assumed for the industrial worker.

The resident gardener land use was considered to be a "less likely but plausible" land use scenario as defined in NUREG-1757, Table 5-1. RESRAD was used, in conjunction with Excel spreadsheet, to calculate the dose from the Resident Gardener alternate scenario. NUREG-1757 states that if the peak dose from a less likely put plausible scenario is "significant", then greater assurance that the scenario is unlikely would be necessary. The alternate scenario is addressed in section 6.15.

6.6. Mixture Fractions for Initial Suite Radionuclides

A comprehensive "initial suite' of 22 radionuclides were identified that could potentially be present at the LACBWR site. As discussed below, the initial suite includes many radionuclides that have not been positively identified in LACBWR 10 CFR Part 61 analysis or during characterization but could theoretically be present, albeit at very low mixture fractions, relative the primary radionuclide which is Cs-137.

The initial suite mixture fractions were used in conjunction with the soil DCGLs and BFM DCGLs to identify the insignificant dose contributors and final list of ROC that will be considered during the FSS and final dose summation for compliance as described in section 6.5.6.

6.6.1. Potential Radionuclides of Concern and Initial Suite

Energy*Solutions* TSD RS-TD-313196-001, *Radionuclides of Concern During LACBWR Decommissioning*, (5) established an initial suite of potential ROC. Two industry guidance documents were reviewed including NUREG/CR-3474, *Long-Lived Activation Products in Reactor Materials,* (6), and NUREG/CR-4289, *Residual Radionuclide Concentration Within and Around Commercial Nuclear Power Plants; Origin, Distribution, Inventory, and Decommissioning Assessment* (7). The review also included an evaluation of a LACBWR spent fuel inventory assessment conducted in 1988 that was decay corrected to January 2015. Several 10 CFR Part 61 waste stream analyses were also reviewed.

The list of activation product radionuclides for consideration in the initial suite was developed after eliminating noble gases, radionuclides with half-lives less than two years, and radionuclides with theoretical neutron activation products with abundances less than 0.01 percent relative to Co-60 and Ni-63 (the prominent activation products identified in LACBWR 10 CFR Part 61 samples). The review of Reference (7), which includes both activation and fission products, coupled with review of the LACBWR fuel inventory and 10 CFR Part 61 analyses resulted in several additional radionuclides being included in the list of those that could be potentially present during the decommissioning of LACBWR.

Finally, the results of concrete core samples collected from the Waste Treatment Building (WTB), Reactor Building and Piping and Ventilation Tunnels were reviewed. No radionuclides were positively identified that were not already accounted for by the assessments described above.

The resulting list of potentially present radionuclides is called the "Initial Suite" and is provided in Table 6-3. The process for determining the mixture fractions is described below.

6.6.2. Radionuclide Mixture Fractions

As described in Reference (5), the mixture fractions for the initial suite radionuclides were developed from the 38 concrete cores collected during initial and continuing characterization of the Reactor Building, WTB, WGTV, and Piping/Ventilation Tunnels. The core data was decayed to the scheduled license termination date of March 2020. The vast majority of the activity was located in the first 1.27 cm slices from the cores which were therefore used for the mixture calculation. The use of cores with higher concentrations provides the most accurate estimate of mixture fractions by minimizing the bias caused by non-detect results.

Three different methods were used in Reference (5) to calculate the mixture fractions which are summarized as follows:

1. The first was to calculate the radionuclide activity fraction, $fA_{i,j,k}$, for each sample, j, each radionuclide, i, within each population, k, from the reported radionuclide activity concentrations, $C_{i,j,k}$, using Equation 6-1 and then calculating the average activity fraction, $fA_{i,j,k}$, for each radionuclide, i, and population, k, of N samples using Equation 6-2.

Equations 6-1 and 6-2

$$fA_{i,j,k} = \frac{C_{i,j,k}}{\sum(j)C_{i,j,k}}$$

$$fA_{i,k} = \frac{\sum(j)fA_{i,j,i}}{N}$$

2. The second was to calculate the 75th percentile of the population of samples from Equations 6-1 above. Once the 75th percentile fraction were calculated for each radionuclide, $f_{i,k,.75}$, data set was re-normalized to determine the percentile-based activity fractions, $fA_{i,k,.75}$ using Equation 6-3.

Equation 6-3

$$fA_{i,k,.75} = \frac{f_{i,j,k,.75}}{\sum(j)fA_{i,j,k,.75}}$$

3. The third was to calculate the individual radionuclide ratios to Cs-137 for each sample, $R_{i,Cs\text{-}137,j}$, calculate the 75th percentile for the sample group, $R_{i,Cs\text{-}137,k,.75}$ then renormalize to determine the activity fractions, $f_RA_{i,k,.75}$ using **Equation 6-4**.

Equation 6-4

$$f_RA_{i,k,.75} = \frac{R_{i,Cs-137,k,.75}}{\sum(i)R_{i,Cs-137,k,.75}}$$

The analyses give equal statistical weight to each of the sample results and are not affected by activity weighted averaging. Also, the analyses apply the actual reported activity concentrations in the calculation of activity fractions regardless of whether the reported activity was less than the detectability criteria.

The 75th percentile values were calculated to conservatively account for uncertainty in the mixture fractions. It is recognized that a higher percentile value will provide a different mixture profile, but such an approach would give undo weight to outliers of the samples population. In addition, there is precedence in using the 75th percentile, particularly in the parameter selection process for dose modeling to support DCGL calculations. The 75th percentile is therefore considered sufficient to provide overall conservatism in the development of the radionuclide mixtures.

The results of the three methods were evaluated in section 6.3 of Reference (5). The two methods involving the use of the 75th percentiles (Equations 6-3 and 6-4) provide very similar results, particularly the dose fraction attributed to the insignificant contributor (IC) radionuclides (see

section 6.13 for discussion of IC dose fractions), and both are more conservative than using averages (Equations 6-1 and 6-2). It was initially expected that the method using the "75th percentile of the Cs-137 fractions" (Equation 6-4) would yield higher IC dose fractions in all cases. However, the data shows that the IC dose fractions are maximized slightly higher for soil and the Reactor Building using Equation 6-4 but slightly lower (by 0.2%) for the WGTV as compared to the 75th percentile of the activity averages (Equation 6-3). But the differences appear to be within the overall uncertainties and variance of the data sets leading to a conclusion that the methods are effectively very similar. For consistency and simplicity, the "75th percentile of the Cs-137 fractions" was chosen to conservatively represent the overall nuclide mixtures for soil, the Reactor Building, and the WGTV. The soil mixture fractions are also applied to buried pipe and above grade buildings.

The mixture fractions for the Reactor Building and WGTV are based on cores collected from the respective buildings. For soil, there were only a few positive soil sample results identified during characterization, predominantly Cs-137, and the concentrations were insufficient to provide a meaningful evaluation of the relative mixture fractions for the HTD radionuclides which were all reported as less than the MDC. Therefore, the soil radionuclide mixture fractions were determined from an analysis of all 38 concrete cores under the premise that the source of soil contamination could be from any of the LACBWR buildings during operation as well during remediation and demolition.

The radionuclide mixtures for soil, Reactor Building and WGTV are listed in Table 6-3.

The analysis of the Np-237 activity fraction in the WGTV is different than the soil and Reactor Building. Np-237 was not detected in any of the 38 samples (see Attachment 2 of Reference (5)). The average reported activity fraction and the normalized 75th percentile fraction are 6.07E-5 and 4.12E-4 respectively (5). These clearly suggest the absence of Np-237. However, even at these low fractions, the values artificially skew the IC dose analysis provided in section since the Np-237 DCGLs are much lower than the other radionuclides. Therefore, the Np-237 IC dose was calculated using an alternate approach to eliminate this artifact as further explained in section 6.13. As such, the Np-237 fraction for the WGTV in Table 6-3 has been set to zero.

Table 6-3 Initial Suite of Potential Radionuclides and Mixture Fractions

Nuclide	Soil Mix Fraction	Rx Bldg Mix Fraction	WGTV Mix Fraction
H-3	1.51E-01	2.36E-02	2.52E-01
C-14	1.72E-03	1.27E-03	9.37E-03
Fe-55	2.36E-02	1.40E-02	-8.13E-03
Ni-59	7.40E-04	2.48E-04	4.74E-02
Co-60	3.43E-02	4.58E-02	4.76E-03
Ni-63	2.64E-01	2.77E-01	1.89E-01
Sr-90	5.22E-02	7.59E-02	9.12E-03
Nb-94	1.68E-04	1.07E-04	1.01E-03
Tc-99	2.06E-03	2.16E-03	6.91E-03
Cs-137	4.41E-01	4.92E-01	4.49E-01
Eu-152	2.93E-03	1.84E-03	4.49E-03
Eu-154	1.50E-03	2.49E-03	1.60E-03
Eu-155	2.08E-03	6.61E-04	4.56E-03
Np-237	2.15E-06	2.17E-06	0.00E+00
Pu-238	1.16E-03	2.27E-03	7.95E-04
Pu-239/240	7.80E-04	3.17E-03	1.90E-04
Pu-241	1.56E-02	4.58E-02	2.35E-02
Am-241	3.56E-03	1.03E-02	3.25E-03
Am-243	5.85E-04	6.18E-04	4.55E-04
Cm-243/244	1.65E-04	1.58E-04	1.78E-04
Total	1.00	1.00	1.00

6.7. Soil Dose Assessment and DCGL

Site-specific DCGLs were developed for residual radioactivity in surface soil that represent the 10 CFR 20.1402 dose criterion of 25 mrem/yr. A DCGL was calculated for each initial suite radionuclide in order to provide an input to the determination of IC dose percentage and the final list of ROC.

The surface soil conceptual model assumes that the soil contamination is contained in a uniformly contaminated 1 m layer of soil from the ground surface downward. There are no expectations that at the time of license termination, residual radioactivity will remain with a geometry consisting of a clean surface layer of soil over a contaminated subsurface soil layer with concentrations exceeding the surface soil DCGL.

6.7.1. Soil Source Term

There is limited potential for significant surface or subsurface soil contamination at LACBWR based on the results of soil characterization performed in 2014. There are indications that subsurface soil contamination may be present under the Turbine Building based on positive groundwater monitoring results down gradient of suspected broken drain lines. However,

GeoProbe samples collected under the Turbine Building in the vicinity of the suspect drain lines did not identify plant-derived radionuclides above background. Additional subsurface soil samples were collected during continuing characterization after the Turbine Building foundation was removed and the underlying soil exposed. Very low levels of plant-derived radionuclides were identified.

Soil characterization results are provided in LTP Chapter 2 and summarized here. A total of 22 biased surface soil samples and 79 subsurface soil samples (at varying depths to six meters) were collected inside the LSE fence. Thirteen of the surface soil sample analyses results indicated Cs-137 above the MDC with a maximum of 1.07 pCi/g. Two of the surface soil sample results indicated Co-60 above the MDC with a maximum of 0.287 pCi/g. Fifteen of the subsurface soil samples indicated Cs-137 above MDC with a maximum of 0.161 pCi/g with no subsurface Co-60 results greater than MDC. The Cs-137 results are all in the range of natural background.

6.7.2. Soil Exposure Pathways and Critical Group

The AMCG at the LACBWR site is the Industrial Worker. The following exposure pathways apply:

- Direct exposure to external radiation
- Inhalation of airborne radioactivity
- Ingestion of soil
- Ingestion of water from onsite well

The agricultural and gardening pathways are not applicable to industrial land use. The meat, milk, grain and vegetable ingestion pathways are therefore not included.

6.8. Soil DCGL Computation Model – RESRAD v7.0

The RESRAD model was used to calculate DCGLs for surface soil. The RESRAD output reports for the modeling discussed below are provided electronically in conjunction with Energy*Solutions* TSD RS-TD-313196-004, *LACBWR Soil DCGL and Concrete DCGL* (8).

6.8.1. Parameter Selection Process

RESRAD parameters are classified as behavioral, metabolic or physical. Some parameters may belong to more than one category. Physical parameters are determined by the geometry and location of the source term and the geological characteristics of the site (i.e., source-specific and site-specific) including the geohydrologic, geochemical, and meteorologic characteristics. The characteristics of atmospheric and biospheric transport up to, but not including, uptake by, or exposure to the dose receptor, are also considered physical input parameters.

Behavioral parameters define the receptor's behavior considering the conceptual model selected for the site. For the same group of receptors, a parameter value could change if the scenario changed (e.g., parameters for industrial use could be different from residential use). For LACBWR, the behavioral parameters are based on an industrial use scenario and are the same for both the BFM and soil dose assessments.

Metabolic parameters define certain physiological characteristics of the potential receptor. One set of metabolic parameters applies to both the BFM and soil dose assessments.

Physical, behavioral and metabolic parameters are treated as deterministic parameters in the final dose modeling to calculate soil DCGLs (and BFM DCGLs). The deterministic module of the code uses single values for input parameters and generates a single value for dose. The parameter selection process is described below.

Argonne National Laboratory (ANL) ranked physical parameters by priority as 1, 2, or 3. Priority 1 parameters have the highest potential impact on dose and Priority 3 the least. This ranking is documented in Attachment B to the ANL report, NUREG/CR-6697, *Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes*, (NUREG/CR-6697) (9).

Priority 3 physical parameters were assigned either a site-specific value or the median values from the Probability Density Functions (PDF) defined in NUREG/CR-6697. Priority 1 and 2 parameters were either assigned site-specific deterministic values, evaluated by uncertainty analysis using the PDFs defined in NUREG/CR-6697, or evaluated by uncertainty analysis using site-specific PDFs. The Partial Rank Correlation Coefficient (PRCC) values from the RESRAD uncertainty analysis were used to evaluate the relative sensitivity of the Priority 1 and 2 parameters. A PRCC value less than -0.25 was considered sensitive and negatively correlated to dose. The 25th percentile of the parameter distribution was assigned to negatively correlated parameters. A PRCC value greater than +0.25 was considered sensitive and positively correlated to dose. The 75th percentile of the parameter distribution was assigned to positively correlated parameters. Priority 1 and 2 parameters with a PRCC absolute value less than 0.25 were assigned the median value of the PDF.

Consistent with the guidance in NUREG-1757, section I.6.4.2, metabolic and behavioral parameters were assigned the mean values from NUREG/CR-5512 Vol. 3, *Residual Radioactive Contamination From Decommissioning Parameter Analysis* (NUREG/CR-5512) (10) Table 6.87.

Figure 6-7 provides a flow chart of the parameter selection process. The set of selected deterministic parameters and PDFs is used in a RESRAD Uncertainty Analysis to determine the final deterministic parameter set used to calculate soil DCGLs. The uncertainty analysis was performed for each radionuclide individually. This conservatively disregards the reduced influence of low abundance radionuclides on the total dose and eliminates the potential impact of uncertainty in mixture fractions. The number of sample runs in the uncertainty analysis ranged from 300 to 500 to manage run time.

6.8.2. RESRAD Parameter Selection for Uncertainty Analysis

Attachment 6-1 provides a table with the deterministic values and PDFs used for the uncertainty analysis. The references or justifications for the parameter selections are listed in Attachment 6-1. The basis for the behavioral and metabolic parameters (NUREG/CR-5512) and the generic PDFs (NUREG/CR-6697) are straightforward and consistent with the process flow chart in Figure 6-7. The Kd PDFs for the contaminated zone, unsaturated zone and saturated zone were correlated in the uncertainty analysis with Rank Correlation Coefficients of 0.99. The basis for the site-specific deterministic parameters and PDFs are discussed in more detail below.

The contaminated area was assumed to be the full 7500 m^2 area inside the LSE fence. The site-specific soil type is sand. The depth of soil contamination was conservatively assumed to be 1 m. This allows for a more efficient remediation (if necessary) and FSS process because a single DCGL applies to the soil depths from 0 to 1 m as opposed to requiring separate DCGLs for 0.0 to 0.15 m and 0.15 m to 1.0 m. Site-specific deterministic values from Reference (1) were applied to the following hydrogeological parameters:

- Contaminated Zone Hydraulic Conductivity,
- Soil Density,
- Soil Porosity,
- Soil Effective Porosity,
- Saturated Zone Hydraulic Gradient.

A site-specific deterministic value was also selected for the "Saturated Zone Field Capacity" parameter based on a calculation performed for a sand soil type in Zion*Solutions* Technical Support Document 14-006, Conestoga Rovers & Associates (CRA) Report, *Evaluation of Hydrological Parameters in Support of Dose Modeling for the Zion Restoration Project* (11).

The Inhalation Rate parameter for the industrial worker AMCG was derived from NUREG/CR-5512, Section 5.3.4 which recommends an inhalation rate for workers in light industry of 1.4 m^3/hr. The annual inhalation rate the industrial worker was then calculated as follows: Inhalation Rate (m^3/yr) = 1.4 m^3/hr*2190 hr/yr = 3066 m^3/yr.

A similar process was followed to determine the Drinking Water Intake Rate parameter for the industrial worker. NUREG/CR-5512, Table 6.87, provides a water intake rate of 478 L/yr for a residential user which corresponds to 1.31 L/d. This rate was conservatively applied as the intake rate for a worker as follows: 1.31 L/d * 250 work days/yr = 327 L/yr.

The RESRAD parameters Indoor and Outdoor Time Fractions were derived from NUREG/CR-6697 Att. C, Table 7.6-1, which recommends a median indoor work day of 8.76 hours/day. Assuming 5 days a week and 50 weeks per year, this equates to 2190 hours per year. The majority of industrial work is expected to be indoors. Consistent with Table 2-3 of the ANL report *User's Manual for RESRAD Version 6* (12), 75% of work time is assumed to be indoors and 25% outdoors. The corresponding RESRAD Indoor Fraction parameter = (2190*0.75)/(24*365) = 0.1875. The Outdoor Time Fraction is then calculated as (2190*0.25)/(24*365) = 0.0625.

Site-specific PDFs were developed for the Well Pump Intake Depth and Well Pumping Rate Parameters. There are two existing onsite industrial water supply wells supporting LACBWR. The well depths are 116 feet and 129 feet below the ground surface (bgs) (1). The 129 foot depth is 36.3 m below the maximum water table elevation 629 feet. The 36.3 m depth is assumed to be maximum well depth. The minimum well depth is assumed to be represented by a nominal 20 foot screen depth (6.1 m) starting at the maximum water table elevation. The mode of the recommended triangular distribution is assumed to be mid-point between 6.1 m and 36.3 m which is 21.2 m. Note that the site-specific distribution is reasonably similar to the NUREG/CR-6697 distribution values of 6, 10, and 30 for the triangular distribution.

NUREG/CR-6697 does not provide a recommended value for well pumping rate due to high variability. For an industrial use scenario, the pump rate depends on industry. To ensure that well pumping rate is included in the uncertainty analysis, a nominal uniform distribution was developed. NUREG-6697, Table 3.10-1 applies a sanitary and potable water usage rate for four persons of 328.7 m^3/yr. This value is assumed to be the minimum industrial well pumping rate assuming four workers. A nominal maximum rate is assumed based on supply to 20 workers which equates to 1643.5 m^3/yr. These minimum and maximum values are not intended to predict actual water use at an unknown future industrial facility on the site after license termination but to provide a range that can be used to determine if the dose is sensitive to well pumping rate.

The remaining parameters in Attachment 6-1 not discussed above were selected in accordance with the process flow chart in Figure 6-7.

6.8.3. Soil DCGL Uncertainty Analysis Results

The full RESRAD Uncertainty Reports for Soil DCGL parameters are provided electronically with Reference (8). The uncertainty analysis results are provided in Table 6-4 and Table 6-5.

Table 6-4 Soil DCGL Uncertainty Analysis Results for Kd and Selected Deterministic Values

Nuclide	Correlation to Dose	Basis of Deterministic Parameter Selection[1]	Selected Deterministic Value (cm^3/g)	Nuclide	Correlation to Dose	Basis of Deterministic Parameter Selection[1]	Selected Deterministic Value (cm^3/g)
H-3	NS[2]	mean	0.06	Eu-154[3]	NS	mean	825
C-14	NS	mean	5	Eu-155[3]	NS	mean	825
Fe-55	NS	mean	220	Np-237	Negative	25th	1
Ni-59	Positive	75th	1110	Pu-238	NS	mean	550
Co-60	NS	mean	60	Pu-239	NS	mean	550
Ni-63	Positive	75th	1110	Pu-240	NS	mean	550
Sr-90	NS	mean	15	Pu-241	NS	mean	550
Nb-94	NS	mean	160	Am-241	NS	mean	1900
Tc-99	Negative	25th	0.04	Am-243	NS	mean	1900
Cs-137	NS	mean	280	Cm-243	NS	mean	4000
Eu-152[3]	NS	mean	825	Cm-244	NS	mean	4000

Note 1: Mean values for sand from NUREG/CR-6697 Table 3.9.2. The 75th and 25th values for sand from Reference (13)
Note 2: NS indicates non-sensitive parameter.
Note 3: Sand Kds not listed in NUREG-6697 Table 3.9-2 for this radionuclide. The mean value from NUREG-6697 was used.

The deterministic Kd values assigned to radionuclides that are sensitive to Kd are the 75th or 25th percentile values from the sand Kd distributions in Sheppard and Thibault, *Default Soil/Solid /Liquid Partition Coefficients, K_ds, for Four Major Soil Types: A Compendium*, (13) which are listed in Reference (8). The Kd values assigned to radionuclides that were not sensitive to Kd were assigned the mean deterministic values for sand from Reference (13) as listed in NUREG-6697, Table 3.9-2.

Table 6-5 Soil DCGL Uncertainty Analysis Results for Non-Nuclide Specific Parameters and Selected Deterministic Values

Parameter	Correlation to Dose	Radionuclide	Basis of Deterministic Parameter Selection	Selected Deterministic Value
Contaminated zone erosion rate	Positive	Nb-94	75th	0.0029
Contaminated zone b parameter	NS	NA	median	0.97
Evapotranspiration coefficient	Negative	H-3, Tc-99	25th	0.56
Wind Speed[1]	Negative	Am-241, C-14, Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241,	Minimum Site-Specific Monthly Average[1]	3.7
Runoff coefficient	Negative	H-3, Np-237, Tc-99	25th	0.27
Saturated zone b parameter	NS	NA	median	0.97
Well pump intake depth	Negative	H-3, Np-237, Tc-99	minimum site-specific value	6.1
b Parameter of Unsaturated zone	NS	NA	median	0.97
Mass loading for inhalation	Positive	Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241,	75th	2.87E-05
Indoor dust filtration factor	Positive	Cm-243, Cm-244, Fe-55, Ni-59, Ni-63, Pu-238, Pu-239, Pu-240, Pu-241	75th	0.75
External gamma shielding factor	Positive	Am-241, Am-243, Cm-243, Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Nb-94, Np-237, Pu-241, Sr-90	75th	0.40
Well Pumping Rate	NS	NA	median	986.1
Depth of Soil Mixing Layer	NS	NA	median	0.23

(1) Site-specific average wind speed data from Wisconsin State Climatology Office converted to m/s (Web Address: http://www.aos.wisc.edu/~sco/clim-history/7cities/la_crosse.html)

6.9. Soil Deterministic Analysis and Soil DCGLs

The soil DCGLs were calculated using the parameter set provided in Attachment 6-1 with the PDFs replaced by the deterministic values listed in Table 6-4 and Table 6-5. The full RESRAD Summary Report for Soil DCGLs is provided electronically with Reference (8). The Soil DCGLs for the Initial Suite are listed in Table 6-6.

Table 6-6 LACBWR Soil DCGLs for Initial Suite Radionuclides

Radionuclide	Soil DCGL (pCi/g)
H-3	1.746E+04
C-14	2.448E+05
Fe-55	1.018E+07
Ni-59	2.594E+07
Co-60	1.281E+01
Ni-63	9.478E+06
Sr-90	6.586E+03
Nb-94	2.018E+01
Tc-99	3.563E+02
Cs-137	5.812E+01
Eu-152	2.844E+01
Eu-154	2.636E+01
Eu-155	1.122E+03
Np-237	7.991E-01
Pu-238	1.660E+03
Pu-239	1.494E+03
Pu-240	1.496E+03
Pu-241	3.637E+04
Am-241	1.089E+03
Am-243	1.868E+02
Cm-243	2.884E+02
Cm-244	2.668E+03

6.10. Basement Fill Conceptual Model

The BFM is used to calculate dose to the industrial worker AMCG from residual radioactivity in the backfilled basements to remain after license termination. A general description of the BFM conceptual model was provided in section 6.5.1. This section describes the conceptual model in more detail including assumed physical configuration, geohydrology, source-term and exposure pathways. The computational model is described in sections 6.11 and 6.12.

The BFM conceptual model assumes that all structures are removed to a depth of three feet bgs (639 foot), i.e., to an elevation of 636 foot, and then backfilled. The site groundwater is in direct communication with the Mississippi river resulting in river driven seasonal groundwater fluctuation. The maximum groundwater elevation is 629 foot. Although the maximum elevation is seasonal, the water table is assumed to be constantly present at 629 foot.

The BFM includes two scenarios; *in-situ* (designated as "Insitu" in this Chapter) and Excavation. The BFM Insitu scenario includes two exposure pathways; ingestion of drinking water from an onsite well and direct exposure to drilling spoils that are assumed to be brought to the surface during the installation of the onsite well. The BFM Excavation scenario assumes large scale industrial excavation of some or all of the backfilled concrete and spreading the concrete over a 1 m layer on the ground surface. The dose from the Insitu and Excavation scenarios are summed in the DCGL calculation.

6.10.1. Source Term

The source term for the BFM is the residual radioactivity remaining in the backfilled basement End State at the time of license termination. LTP Chapter 2 provides the characterization data for the basements that will remain. The dimensions and surface areas are provided in RS-TD-313196-002 *Final LACBWR End State Basement Concrete Surface Areas, Volumes, and Void Spaces* (14). The expected source term configurations and activity levels projected to remain in each basement are summarized below.

6.10.1.1. Reactor Building

The Reactor Building is a right circular cylinder with a hemispherical dome and semi-ellipsoidal bottom. It has an overall internal height of 144 feet and an inside diameter of 60 feet, and it extends 26 feet 6 inches below grade level. The steel shell thickness is 1.16 inch, except for the upper hemispherical dome, which is 0.60 inch thick. The lowest floor elevation is at 612 foot elevation.

The total wall/floor surface area in the portion of the building to be backfilled, i.e., below 636 foot elevation, is 512 m^2. T Remediation plans call for all below grade concrete interior to the steel liner to be removed exposing the steel liner. . The liner, and remaining structural concrete outside the liner, that is below the 636 foot elevation will remain. The remaining concrete "bowl" sits on an external support structure comprised of a concrete pile cap and piles. The pile cap and piles were isolated from reactor operations by the interior concrete, the steel liner and the exterior concrete bowl. There is no evidence of contamination leakage beyond the steel liner or the concrete bowl exterior to the liner, therefore the pile cap and piles are considered to be non-impacted areas.

Six 1.27 cm thick core slices were collected from the surface downward and shipped to an offsite laboratory for analysis. The cores were collected from biased locations as indicated by elevated survey measurements and represent the areas expected to contain the highest levels of contamination. As shown in Table 6-3, Cs-137 is the predominate radionuclide at 88% of the radionuclide mixture. The Cs-137 results from the six cores ranged from 66 pCi/g to 7,500 pCi/g with an average of 1,903 pCi/g.

There is no indication that contamination is present in the concrete exterior to the steel liner, therefore no cores were collected from the concrete exterior to the steel liner. In addition, general cleanup of loose contamination on the steel liner (concrete dust) after demolition and removal of the internal concrete is expected for operational radiation protection purposes. This reduces the already low potential for transfer of activity in contaminated dust to the liner. Therefore, minimal source term is expected in the Reactor Building End State.

6.10.1.2. Waste Gas Tank Vault

The WGTV is a 29 foot by 31 foot underground concrete structure with 14 feet high walls and 2 feet thick floors, walls, and ceiling located 3 feet bgs just outside of the WTB. The gas decay system routed main condenser gases through various components for drying, filtering, recombining, monitoring and holdup for decay in the WGTV. The vault floor is at 621 foot elevation. A small sump is present that extends to 618 foot elevation.

Eight concrete cores were collected from the WGTV in September 2017 during continuing characterization. Cs-137 was positively detected in seven of the eight cores with concentrations ranging from 4.4 pCi/g to 240 pCi/g. Very low concentrations of Co-60, Ni-63, Pu-238, Pu-239/240, Pu-241, and Am-241 were sporadically identified in three cores with a range of 0.021 pCi/g to 10.5 pCi/g.

6.10.2. BFM Exposure Pathways

The BFM includes two exposure scenarios, Insitu and Excavation. As discussed in section 6.4 the "reasonably foreseeable" future land use at the LACBWR site is industrial and the AMCG is therefore the industrial worker.

The following exposure pathways are applicable to the BFM scenarios:

- Direct exposure to external radiation in "as left" End State geometry (negligible),
- Inhalation of airborne radioactivity in "as left" End State geometry (negligible),
- Ingestion of concrete or fill material in "as left" End State geometry (negligible),
- Ingestion of water from onsite well,
- Direct exposure, inhalation dose and ingestion dose from contaminated drilling spoils brought to the surface during installation of the onsite well into the fill material, and
- Direct exposure, inhalation dose and ingestion dose from concrete that is brought to the surface by excavation.

The agricultural and gardening pathways are not applicable to industrial land use. The meat, milk, grain and vegetable ingestion pathways are therefore not included.

6.11. BFM Insitu Scenario

6.11.1. BFM Insitu Groundwater Scenario

The BFM Insitu groundwater (BFM Insitu_{gw}) conceptual model is based on a conservative screening approach. One hundred percent of the inventory in the backfilled basement concrete is assumed to instantly release and mix with the fill material at the time of license termination with no credit for decay. RESRAD is then used to perform the dose modeling assuming that the source term is in the fill and that the structures provide no resistance to groundwater flow, i.e., are not present.

The two remaining basements (Reactor Building and WGTV) have different geometries and contamination potential and are therefore modeled as separate contaminated zones with portions above and below the water table after backfill. This configuration is addressed in the RESRAD model using the "contaminated fraction below the water table" parameter. The conceptual model assumes full mixing over the fill volume. For the portions of the Reactor Building and WGTV that are below the maximum water table elevation of 629′, full mixing over the entire fill volume below 629′ is a reasonable assumption given that the fill is saturated and the conceptual model assumes unrestricted groundwater flow. Mixing within the fill that is above the 629′ water table elevation is more uncertain because the source of the water is vertical rainwater infiltration as

opposed to horizontal flowing groundwater. To evaluate the effect of mixing volume, a sensitivity analysis was conducted to determine the dependence of dose on the mixing distance into the fill (see section 6.15).

6.11.1.1. BFM Insitu$_{gw}$ Computation Model

RESRAD was used to calculate Dose to Source Ratios (DSR), with units of mrem/yr per pCi/g, for each radionuclide in the initial suite. Separate DSRs were calculated for the Reactor Building and WGTV. The DSRs were then used in conjunction with unitized fill concentrations (i.e., the pCi/g concentration in fill resulting from the release of 1 pCi/m^2 from the structure concrete) to calculate DCGLs for the BFM Insitu$_{gw}$ scenario in units of pCi/m^2. The BFM Insitu$_{gw}$ DCGL calculations are provided in Reference (8).

6.11.1.2. BFM Insitu$_{gw}$ RESRAD Uncertainty Analysis for Initial Suite

An uncertainty analysis was performed to select deterministic RESRAD parameters for the calculation of DSRs for the BFM Insitu$_{gw}$ model. The process for determining the input parameters for the BFM Insitu$_{gw}$ RESRAD uncertainty analysis was the same as that used for the soil DCGL uncertainty analysis (see process flowchart in Figure 6-7).

The parameter set developed to perform the soil DCGL uncertainty analysis is applicable to the BFM Insitu$_{gw}$ analysis with changes to account for the geometries of the backfilled structures. The affected RESRAD geometry parameters are Cover Depth, Area of Contaminated Zone, Thickness of Contaminated Zone, Length Parallel to Aquifer Flow, Unsaturated Zone Thickness, and Fraction of Contaminated Zone below the Water Table.

The uncertainty analysis was performed separately for the two structures to remain at license termination; i.e., Reactor Building and WTGV. The parameters used for the five BFM Insitu$_{gw}$ uncertainty analyses are listed in Attachment 6-2. The parameters listed as "Variable" in Attachment 6-2 were assigned the values shown in Table 6-7 for the respective structures.

Table 6-7 Deterministic Geometry RESRAD Parameters used in the Uncertainty Analysis for the Two BFM Insitu$_{gw}$ Configurations

Parameter	Rx Building Above 619'	WGTV
Cover Depth (m)	0.91	0.91
Area of Contaminated Zone (m^2)	262.68	86.33
Thickness of Contaminated zone (m)	7.32	4.57
Length Parallel to Aquifer Flow (m)	18.29	9.6
Unsaturated Zone Thickness (m)	0	0
Contaminated Fraction Below the Water Table	0.71	0.53

The uncertainty analysis was performed for each radionuclide individually. This conservatively disregards the reduced influence of low abundance radionuclides on the total dose and eliminates the potential impact of uncertainty in mixture fractions. The RESRAD Uncertainty Reports are provided electronically with Reference (8).

The Kd values are radionuclide-specific. The uncertainty analyses for all radionuclides, except Nb-94 which had a positive PRCC value near zero, showed a negative correlation between dose

and Kd. With a few exceptions, the negative correlation exceeded the PRCC threshold of |0.25|. The predominance of negative correlation with Kd was expected because the majority of the contamination is below the water table and the primary dose pathway in the BFM $Insitu_{gw}$ scenario is through the ingestion of well water. To ensure conservatism, the deterministic Kd values selected for all negatively correlated radionuclides, in both the Reactor Building and WGTV, were the 25th percentile values from Reference (13). The positive correlation to the Nb-94 Kd was investigated further primarily because a cross-check of the Standardized Rank Regression Coefficient (SRRC) indicated more significant positive correlation than the PRCC. The cause of the positive correlation was found to be direct dose from the water independent pathway after long term cover erosion. The maximum Nb-94 dose occurs when the 75th percentile Kd is applied, as opposed to the 25th percentile, for both the Reactor Building and WGTV. The time of maximum dose is year 312. This result is due to the unique decay characteristics of Nb-94 which include gamma emission with a very long half-life. The 75th percentile Kd was applied to ensure conservatism.

The parameter distributions for the site-specific soil type of sand from Reference (13) were used to generate the 25th and 75th percentile deterministic values. Note that Reference (13) does not contain values for Europium; the 25th percentile from the NUREG-6697 Kd parameter distribution was used. The assigned Kd values for all radionuclides are listed in Table 6-8.

Table 6-8 BFM $Insitu_{gw}$ Reactor Building and WGTV Deterministic Values Selected for Distribution Coefficients (Kd)

Radionuclide	Kd in Contaminated Zone and Saturated Zone (No Unsaturated Zone Present)	
	Correlation	Value (cm^3/g)
H-3	Negative	0.05
C-14	Negative	1.8
Fe-55	Negative	38
Ni-59	Negative	147
Co-60	Negative	9
Ni-63	Negative	147
Sr-90	Negative	5
Nb-94	Positive	611
Tc-99	Negative	0.04
Cs-137	Negative	50
Eu-152[1]	Negative	95
Eu-154[1]	Negative	95
Eu-155[1]	Negative	95
Np-237	Negative	1
Pu-238	Negative	173
Pu-239/240	Negative	173
Pu-241	Negative	173
Am-241	Negative	329
Am-243	Negative	329
Cm-243/244	Negative	881

Table 6-9 and Table 6-10 provide the uncertainty analysis results for the parameters that are not radionuclide-specific (i.e., all parameters other than Kd) and the selected deterministic values. If a parameter is sensitive for any radionuclide the corresponding deterministic value (75th or 25th percentile depending on the correlation) is assigned to all radionuclides. This approach can be used since there are no inconsistencies in the results of the uncertainty analysis, i.e., no parameters were positively correlated for one radionuclide and negatively correlated for another.

Table 6-9 Reactor Building: BFM Insitu$_{gw}$ Uncertainty Analysis Results and Deterministic Values Selected for Non-Nuclide Specific Parameter Distributions

Parameter	Correlation to Dose[1]	Radionuclide	Basis of Deterministic Parameter Selection	Selected Deterministic Value
Contaminated zone erosion rate	NS	NA	median	0.0015
Contaminated zone b parameter	NS	NA	median	0.97
Evapotranspiration coefficient	NS	NA	median	0.62
Wind Speed[2]	NS	NA	median	4.5
Runoff coefficient	NS	NA	median	0.45
Saturated zone b parameter	NS	NA	inactive	NA
Well pump intake depth	Negative	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, Eu-155, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Am-243, Pu-241, Cm-243, Cm-244	25th Percentile	6.1
Mass loading for inhalation	NS	NA	median	2.35E-05
Indoor dust filtration factor	NS	NA	median	0.55
External gamma shielding factor	NS	NA	median	0.27
Well Pumping Rate	NS	NA	median	986.1
Depth of Soil Mixing Layer	NS	NA	median	0.15
Cover Erosion Rate	Positive	Nb-94, Cs-137, Eu-152, Eu-154, Am-243	75th Percentile	0.0029

(1) NS = Not Sensitive
(2) Site-specific annual average wind speed from Wisconsin State Climatology Office converted to m/s (Web Address http://www.aos.wisc.edu/~sco/clim-history/7cities/la_crosse.html)

Table 6-10 WGTV: BFM Insitu$_{gw}$ Uncertainty Analysis Results and Deterministic Values Selected for Non-Nuclide Specific Parameter Distributions

Parameter	Correlation to Dose[1]	Radionuclide	Basis of Deterministic Parameter Selection	Selected Deterministic Value
Contaminated zone erosion rate	NS	NA	Median	0.0015
Contaminated zone b parameter	NS	NA	Median	0.97
Evapotranspiration coefficient	NS	NA	Median	0.62
Wind Speed[2]	NS	NA	Median	4.5
Runoff coefficient	NS	NA	Median	0.45
Saturated zone b parameter	NS	NA	Inactive	NA
Well pump intake depth	Negative	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, Eu-155, Np-237, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Am-243, Cm-243, Cm-244	Minimum Depth	6.1
Mass loading for inhalation	NS	NA	Median	2.35E-05
Indoor dust filtration factor	NS	NA	Median	0.55
External gamma shielding factor	NS	NA	Median	0.27
Well Pumping Rate	NS	NA	Median	986.1
Depth of Soil Mixing Layer	NS	NA	Median	0.15
Cover Erosion Rate	Positive	Nb-94, Cs-137, Eu-152, Eu-154, Am-241, Am-243	75th Percentile	0.0029

(1) NS = Not Sensitive
(2) Site-specific annual average wind speed data from Wisconsin State Climatology Office converted to m/s (Web Address: http://www.aos.wisc.edu/~sco/clim-history/7cities/la_crosse.html)

6.11.1.3. BFM Insitu$_{gw}$ RESRAD Deterministic Analysis and DSR Results

As discussed above, the BFM Insitu$_{gw}$ RESRAD dose assessments were performed separately for the Reactor Building and WGTV. The parameters provided in Attachment 6-2 were applied to both analyses with the two exceptions; 1) the deterministic values in Table 6-7 were used to replace the parameters listed as "variable" in Attachment 6-2 and 2) the values in Table 6-8, Table 6-9 and Table 6-10 provide the uncertainty analysis results for the parameters that are not radionuclide-specific (i.e., all parameters other than Kd) and the selected deterministic values. If a parameter is sensitive for any radionuclide the corresponding deterministic value (75th or 25th percentile depending on the correlation) is assigned to all radionuclides. This approach can be used since there are no inconsistencies in the results of the uncertainty analysis, i.e., no parameters were positively correlated for one radionuclide and negatively correlated for another.

Table 6-9, and Table 6-10 were used to replace the PDFs listed in Attachment 6-2.

The RESRAD Uncertainty Reports are provided electronically with Reference (8). The resulting DSRs are provided in Table 6-11.

Table 6-11 BFM Insitu$_{gw}$ DSRs for Reactor Building and WGTV

Radionuclide	Rx Building (mrem/yr per pCi/g)	WGTV (mrem/yr per pCi/g)
H-3	5.916E-03	2.703E-03
C-14	1.581E-01	8.069E-02
Fe-55	3.787E-03	1.852E-03
Ni-59	3.940E-04	2.032E-04
Co-60	6.691E-01	3.759E-01
Ni-63	1.079E-03	5.003E-04
Sr-90	6.440E+00	3.661E+00
Nb-94	1.546E-01	6.640E-02
Tc-99	1.355E-01	6.195E-02
Cs-137	2.674E-01	1.295E-01
Eu-152	1.824E-02	8.675E-03
Eu-154	2.649E-02	1.260E-02
Eu-155	4.112E-03	1.955E-03
Np-237	3.887E+02	1.854E+02
Pu-238	5.089E+00	2.398E+00
Pu-239	5.652E+00	2.911E+00
Pu-240	5.651E+00	2.907E+00
Pu-241	1.090E-01	5.311E-02
Am-241	3.066E+00	1.499E+00
Am-243	3.054E+00	1.567E+00
Cm-243	7.831E-01	3.658E-01
Cm-244	6.260E-01	2.924E-01

6.11.1.4. BFM Insitu$_{gw}$ DCGL

The BFM Insitu$_{gw}$ DCGLs were calculated in Reference (8) using Equation 6-5.

Equation 6-5

$$BFM\ Insitu\ (gw) DCGL(i) = \frac{25}{DSR(i) * Unit\ Fill\ Concentration}$$

Where:

BFM Insitu (gw) DCGL = DCGL for radionuclide (i) (pCi/m^2)

DSR (i) = RESRAD Dose to Source Ratio for radionuclide i (mrem/yr per pCi/g)

Unit Fill Concentration = Basement-specific concentration in fill (pCi/g) assuming release of unit inventory of 1 pCi/m^2 from concrete (pCi/g per pCi/m^2)

The BFM Insitugw DCGLs are listed in Table 6-12. Note that the DCGLs for the initial suite radionuclides provided in Table 6-12 (and in Table 6-13 and Table 6-15) are calculated values only and do not indicate the concentrations relative to Cs-137 that are present or could be present at license termination. The site-specific radionuclide mixture fractions are provided in Table 6-3.

Table 6-12 BFM Insitu$_{gw}$ DCGLs[1]

Radionuclide	Rx Building BFM Insitu$_{gw}$ DCGL (pCi/m^2)	WGTV BFM Insitu$_{gw}$ DCGL (pCi/m^2)
H-3	2.16E+10	1.60E+10
C-14	8.08E+08	5.35E+08
Fe-55	3.37E+10	2.33E+10
Ni-59	3.24E+11	2.13E+11
Co-60	1.91E+08	1.15E+08
Ni-63	1.18E+11	8.63E+10
Sr-90	1.98E+07	1.18E+07
Nb-94	8.26E+08	6.50E+08
Tc-99	9.43E+08	6.97E+08
Cs-137	4.78E+08	3.34E+08
Eu-152	7.00E+09	4.98E+09
Eu-154	4.82E+09	3.43E+09
Eu-155	3.11E+10	2.21E+10
Np-237	3.29E+05	2.33E+05
Pu-238	2.51E+07	1.80E+07
Pu-239	2.26E+07	1.48E+07
Pu-240	2.26E+07	1.49E+07
Pu-241	1.17E+09	8.13E+08
Am-241	4.17E+07	2.88E+07
Am-243	4.18E+07	2.76E+07
Cm-243	1.63E+08	1.18E+08
Cm-244	2.04E+08	1.48E+08

Note 1: The DCGLs for the initial suite radionuclides are calculated values only and do not indicate the concentrations relative to Cs-137 that are present or could be present at license termination. The site-specific radionuclide mixture fractions are provided in Table 6-3.

6.11.2. BFM Insitu Drilling Spoils Scenario and DCGL Calculation

The BFM Insitu Drilling Spoils (BFM $Insitu_{ds}$) scenario addresses one of the BFM exposure pathways listed in section 6.10.2. The dose from residual radioactivity in the concrete is assumed to be brought to the surface during the installation of a well that randomly hits backfilled structural concrete. The driller is assumed to be unaware that the backfilled structure is present. The residual radioactivity in the concrete surfaces is brought to the surface with the drilling spoils which includes the fill material above the structure floor. The source term for the BFM $Insitu_{ds}$ scenario is the residual radioactivity remaining in concrete at the time of license termination assuming no decay or release to the fill. The BFM $Insitu_{ds}$ DCGLs are calculated with units of pCi/m^2.

There are a number of ways that installers handle and dispose of drilling spoils, including the use of slurry pits, tanks, and dumping the drilling spoils on the existing surface soils. The use of pits would likely involve additional dilution by refilling the pit with the material excavated during its construction. As a conservative assumption, no dilution of the spoil material is assumed after being brought to the surface.

The well is assumed to be drilled into the basement fill down to the concrete floor where refusal is met and drilling stopped. The extent of drilling into concrete is assumed to be sufficient to capture 100 percent of the remaining residual radioactivity in the concrete, at all depths, within the borehole area. The volume of spoil material brought to the surface is calculated based on the borehole diameter and depth of drilling which is conservatively assumed to be the minimum fill depth of three feet which minimizes the mixing volume for both basements. The concrete and fill are uniformly mixed and spread over a circular area on the ground surface to a depth of 0.15 m. The three-foot drilling depth represents the minimum backfill depth after demolition to three feet below grade.

Both basement floors are greater than three feet deep and therefore assuming a three foot well depth is conservative for all basements. Because the same fill depth was assumed for both basements the BFM $Insitu_{ds}$ DCGLs are the same for both basements.

The dose from the circular area at the surface was calculated by RESRAD using the surface soil DCGLs and Area Factors (AF). The AFs were calculated using the deterministic parameters applied for soil DCGLs and the spoils spread area which was determined to be 0.457 m^2. The RESRAD Summary Reports are provided electronically with Reference (8).

The AFs and BFM $Insitu_{ds}$ DCGLs were calculated in Reference (8) using the RESRAD results. The BFM $Insitu_{ds}$ DCGLs are listed in Table 6-13.

Table 6-13 BFM Insitu Drilling Spoils DCGLs for Both Basements[1]

Radionuclide	BFM Insitu$_{ds}$ DCGLs for Both Basements (Reactor Building and WGTV) (pCi/m^2)
H-3	5.09E+13
C-14	4.40E+15
Fe-55	4.53E+16
Ni-59	6.15E+16
Co-60	6.00E+08
Ni-63	2.52E+16
Sr-90	3.41E+11
Nb-94	8.72E+08
Tc-99	1.37E+12
Cs-137	2.45E+09
Eu-152	1.27E+09
Eu-154	1.19E+09
Eu-155	3.44E+10
Pu-238	9.83E+09
Np-237	5.59E+11
Pu-239	5.07E+11
Pu-240	5.11E+11
Pu-241	4.95E+12
Am-241	9.68E+10
Am-243	7.21E+09
Cm-243	1.17E+10
Cm-244	8.90E+11

Note 1: The DCGLs for the initial suite radionuclides are calculated values only and do not indicate the concentrations relative to Cs-137 that are present or could be present at license termination. The site-specific radionuclide mixture fractions are provided in Table 6-3.

6.12. BFM Excavation Scenario

The BFM Excavation scenario assumes that some or all of the backfilled structures are excavated and the concrete spread on the surface immediately after license termination taking no credit for decay. A typical excavation process for a backfilled structure would entail using a medium sized excavator with a 1.0 to 1.5 cubic yard bucket to excavate and stockpile fill. After removing the fill to the planned excavation depth, a hoe-ram would be used to pound out the concrete walls and floor (if the excavation reaches the floor). The concrete would be segregated, the rebar removed, and remaining concrete size reduced. The excavation scenario assumes that the size reduced concrete is used as onsite fill. Large-scale industrial excavation of the entire basement may require different methods but the result would be the same, i.e., a volume of sized concrete to be used as onsite fill.

The DCGLs are calculated to ensure that the average radionuclide concentrations in the excavated, mixed, and sized concrete do not exceed the soil DCGLs which is a conservative

approach given that the surface area of excavated concrete, assuming 1 m spread depth, would be less than the 7500 m^2 area assumed in the calculation of the soil DCGL. The assessment provides BFM Excavation DCGLs in units of pCi/m^2. Due to differences in configuration and contamination potential, the BFM Excavation DCGLs were calculated separately for the Reactor Building and WGTV in the same manner as was done for the BFM Insitu assessments.

The radionuclide concentrations (pCi/g) in the inadvertently mixed, excavated concrete that is assumed to be spread on the site surface is a linear function of the ratio of concrete surface area (SA) to concrete volume (V). The SA/V ratio was calculated in two ways; 1) assuming full excavation of the entire basement, and 2) assuming partial excavation that includes only the walls with the minimum thickness (0.75 feet for both the Reactor Building and WGTV). The walls with minimum thickness will have the maximum SA/V ratio and will result in the maximum concentration in the excavated concrete.

As seen in Table 6-14**Error! Reference source not found.**, the SA/V ratios for the partial excavation of the minimum thickness wall is greater than the SA/V ratio assuming full excavation. To ensure conservatism, the maximum SA/V ratio was used in the DCGL calculation which results in the maximum radionuclide concentrations in the excavated concrete.

Table 6-14 BFM Concrete Excavation SA/V Ratios for Full and Partial Excavation

Structure	Full Excavation SA/V (m^2/m^3)	Partial Excavation SA/V (Minimum Wall Thickness) (m^2/m^3)	Partial SA/V ÷ Full SA/V
Waste Gas Tank Vault	2.55	4.37	1.72
Reactor Building	0.95	4.37	4.61

The BFM Excavation DCGLs are calculated in Reference (8). The results are listed in Table 6-15 and are the same for the Reactor Building and WGTV because the concentrations in the excavated concrete are both based on the same partial (i.e., maximum) SA/V ratio of 4.37.

Table 6-15 BFM Excavation DCGLs for Both Basements[1]

Radionuclide	BFM Excavation DCGLs for Both Basements (Reactor Building and WGTV) (pCi/m^2)
H-3	9.38E+09
C-14	1.32E+11
Fe-55	5.47E+12
Ni-59	1.39E+13
Co-60	6.88E+06
Ni-63	5.09E+12
Sr-90	3.54E+09
Nb-94	1.08E+07
Tc-99	1.91E+08
Cs-137	3.12E+07
Eu-152	1.53E+07
Eu-154	1.42E+07
Eu-155	6.03E+08
Np-237	4.29E+05
Pu-238	8.92E+08
Pu-239	8.03E+08
Pu-240	8.04E+08
Pu-241	1.95E+10
Am-241	5.85E+08
Am-243	1.00E+08
Cm-243	1.55E+08
Cm-244	1.43E+09

Note 1: The DCGLs for the initial suite radionuclides are calculated values only and do not indicate the concentrations relative to Cs-137 that are present or could be present at license termination. The site-specific radionuclide mixture fractions are provided in Table 6-3.

6.13. Basement Summation DCGL

The DCGLs to be used for compliance during FSS of basements (the MARSSIM $DCGL_w$ value) are designated as "DCGL Basement" ($DCGL_B$) and represent the summation of the dose from the three scenarios. The $DCGL_B$ is calculated in Reference (8) using Equation 6-6. The $DCGL_B$ values for the initial suite are provided in Table 6-16.

Equation 6-6

$$DCGL_{B,i,j} = \frac{1}{\Sigma_1^3\left[{}^1/_{DCGL_{BS,i,j}}\right]}$$

Where:

$DCGL_{B,i,j}$ = $DCGL_B$ for radionuclide (i) and basement (j)

$DCGL_{BS}$ =DCGL Basement Scenarios for (i) (Groundwater, Drilling Spoils and Excavation from Table 6-12, Table 6-13 and Table 6-15) and basement (j)

Table 6-16 Summed Basement DCGL ($DCGL_B$) for Initial Suite Radionuclides

Radionuclide	Rx Building $DCGL_B$ (pCi/m^2)	WGTV $DCGL_B$ (pCi/m^2)
H-3	6.54E+09	5.91E+09
C-14	8.03E+08	5.33E+08
Fe-55	3.35E+10	2.32E+10
Ni-59	3.17E+11	2.09E+11
Co-60	6.57E+06	6.42E+06
Ni-63	1.16E+11	8.49E+10
Sr-90	1.97E+07	1.18E+07
Nb-94	1.06E+07	1.05E+07
Tc-99	1.59E+08	1.50E+08
Cs-137	2.90E+07	2.82E+07
Eu-152	1.51E+07	1.51E+07
Eu-154	1.40E+07	1.39E+07
Eu-155	5.81E+08	5.77E+08
Np-237	1.86E+05	1.51E+05
Pu-238	2.44E+07	1.77E+07
Pu-239	2.20E+07	1.46E+07
Pu-240	2.20E+07	1.46E+07
Pu-241	1.11E+09	7.81E+08
Am-241	3.89E+07	2.75E+07
Am-243	2.94E+07	2.16E+07
Cm-243	7.89E+07	6.66E+07
Cm-244	1.79E+08	1.34E+08

The DCGLs for the individual Basement Scenarios ($DCGL_{BS}$) in Table 6-12, Table 6-13 and Table 6-15 are all larger than the $DCGL_B$ values for the same basement in Table 6-16. This is because the $DCGL_{BS}$ represent the concentration that results in a dose of 25 mrem/yr for each scenario individually. For conservatism, the $DCGL_B$ is used for FSS which is the concentration that leads to a dose of 25 mrem/yr under the assumption that all three exposure scenarios occur simultaneously, which is not physically possible.

6.14. Insignificant Dose Contributors, Radionuclides of Concern and Surrogate Ratio

NUREG-1757, section 3.3 states that "radionuclides contributing no greater than 10% of the dose criterion (i.e., 2.5 mrem/yr) are considered to be "insignificant contributors" (IC). The 10% criterion applies to the sum of the dose contributions from the aggregate of IC radionuclides. This section provides the assessment of dose contributions from the initial suite and identifies the radionuclides that can be designated as insignificant dose contributors.

The radionuclides remaining after the removal of IC radionuclides were designated as the ROC. The ROC list is determined for concrete using the BFM $DCGL_B$ values and for soil using the soil DCGLs. The dose from the removed ICs was accounted for by adjusting the soil DCGLs and BFM DCGLs for each ROC. The IC radionuclides are excluded from further detailed evaluations during FSS and demonstration of compliance with the 25 mrem/yr dose criteria.

6.14.1. Insignificant Contributor Dose and Radionuclides of Concern

The soil DCGLs in Table 6-6 and BFM $DCGL_B$ values in Table 6-16 were used in Reference (5) to calculate the dose contributions from the initial suite radionuclides, to identify the IC dose percentage, and to select the ROCs. The IC percentages represent the percentage of the 25 mrem/yr dose limit. The IC percentages were calculated using the 75th percentile mixture fractions as listed in Table 6-3.

The Relative Dose Fraction, $RDF_{i,k}$, for radionuclide i and media k is calculated using the applicable DCGLs, the radionuclide activity fractions from Table 6-3, and Equation 6-7. The results of the calculations are provided in Table 6-17.

Equation 6-7

$$RDF_{i,k} = \frac{fA_{i,k}}{DCGL_{i,k}} \left[\frac{1}{\sum(i) \frac{fA_{i,k}}{DCGL_{i,k}}} \right]$$

Where:

$RDF_{i,k}$	= Relative dose fraction for radionuclide I and media k (soil, Reactor Building and WGTV)
$fA_{i,k}$	= Activity fraction of radionuclide I and media k
$DCGL_{i,k}$	= DCGL for radionuclide I and media k

Table 6-17 Relative Dose Fractions, $RDF_{i,k}$

Radionuclide	ROC ?	Combined Relative Doses, $RDF_{i,k}$ Soil	Rx Bldg	WGTV
H-3		8.27E-04	1.26E-04	2.33E-03
C-14		6.69E-07	5.51E-05	9.61E-04
Fe-55		2.22E-07	1.46E-05	-1.91E-05
Ni-59		2.72E-09	2.73E-08	1.24E-05
Co-60	Y	2.55E-01	2.43E-01	4.05E-02
Ni-63		2.66E-06	8.35E-05	1.22E-04
Sr-90	Y	7.57E-04	1.34E-01	4.24E-02
Nb-94		7.96E-04	3.51E-04	5.22E-03
Tc-99		5.52E-04	4.72E-04	2.51E-03
Cs-137	Y	7.25E-01	5.92E-01	8.70E-01
Eu-152	Y	9.82E-03	4.25E-03	1.63E-02
Eu-154	Y	5.42E-03	6.22E-03	6.29E-03
Eu-155		1.77E-04	3.96E-05	4.32E-04
Np-237		2.56E-04	4.06E-04	0.00E+00
Pu-238		6.65E-05	3.24E-03	2.46E-03
Pu-239/240		4.98E-05	5.01E-03	7.15E-04
Pu-241		4.08E-05	1.44E-03	1.64E-03
Am-241		3.12E-04	9.27E-03	6.46E-03
Am-243		2.99E-04	7.31E-04	1.15E-03
Cm-243/244		5.48E-05	6.99E-05	1.46E-04
Sum		1.00E+00	1.00E+00	1.00E+00
ROC Dose Fraction		9.97E-01	9.79E-01	9.76E-01
IC Dose Fraction		3.44E-03	2.13E-02	2.42E-02

In addition to the relative dose fraction for each radionuclide, Table 6-17 shows the relative doses for the ROC and IC radionuclides as ROC Dose Fraction and IC Dose Fraction respectively. This shows that the IC dose fraction ranges from approximately 0.3% to 2.42% (not including negative values) of the total dose. As noted above, the activity fraction for Np-237 was set to zero for the WGTV in Table 6-3 and must be included in the final calculation of the IC dose fraction.

As discussed above, Np-237 was not detected in any of the 38 samples. Table 6-18 provides summary detection statistics for all samples and for the WGTV.

Table 6-18 Np-237 Detection Statistics

Parameter	Value pCi/g
Min MDC All Samples	0.015
Min MDC WGTV	0.078
Max MDC All Samples	0.239
Max MDC WGTV	0.239
Min Result	-0.062
Max Result	0.102
Average Result	-0.002

The maximum MDC among all samples is 0.239 pCi/g and was used to calculate the Np-237 IC dose fraction for the WGTV (see Reference (5)). The mass-based core concentration (pCi/g) is converted to areal-based concentration (pCi/m^2) by assuming a contamination depth of 1.27 cm (0.5 inch) corresponding to the thickness of each concrete puck and a concrete density of 2.35 g/cm^3. The 0.239 pCi/g MDC corresponds to 7.13E+3 pCi/m^2. From Table 6-16, the WGTV $DCGL_B$ is 1.51E+5 pCi/m^2. Using Equations 6-8 and 6-9, the dose fraction from the IC nuclides, $DF_{IC,WGTV}$, is calculated by adding the dose contribution of Np-237, $TEDE_{Np\text{-}237}$ (1.18 mrem/yr), to the remaining IC dose fractions, DF_{IC}' scaled to 25 mrem ($25*DF_{IC}'$). The resulting $DF_{IC,WGTV}$ is 0.0729.

Equation 6-8

$$DF_{IC',WGTV} = \frac{\sum_{i \neq Np-237}(i) RDF_{i(IC),WGTV}}{\sum_{i \neq Np-237}(i) RDF_{i,WGTV}}$$

Equation 6-9

$$DF_{IC,WGTV} = \frac{25DF_{IC'} + TEDE_{Np-237}}{25} = 0.0729$$

Where:

$DF_{IC',WGTV}$	= Dose fraction of IC radionuclides in the WGTV excluding Np-237
$RDF_{i,WGTV}$	= Relative dose fraction for radionuclide i in WGTV
$DF_{IC,WGTV}$	= IC dose fraction including Np-237 dose (0.0729)
$TEDE_{,Np\text{-}237}$	= Total Effective Dose Equivalent for Np-237 in WGTV (1.18 mrem/yr)

As shown in Table 6-17 and the results of IC dose fraction calculation for the WGTV using Equation 6-9, the IC dose percentage for soil, Reactor Building and WGTV ranged from 0.3% to 7.3%. To provide additional margin beyond the application of the 75th percentile mixture and the conservative approach used to calculate Np-237 dose for the WGTV, the IC dose percentage assigned to adjust the DCGLs for the ROC in all media (soil, basements, buried pipe and above grade building) is increased to 10%.

The ROC are designated as Cs-137, Co-60, Sr-90, Eu-154, and Eu-152. Table 6-19 provides the radionuclide mixture for the ROC renormalized to 1.00.

Table 6-19 ROC Mixture Fractions Renormalized to 1.00

Radionuclide	Soil Mix Fraction	Rx Bldg Mix Fraction	WGTV Mix Fraction
Co-60	6.44E-02	7.41E-02	1.01E-02
Sr-90	9.81E-02	1.23E-01	1.94E-02
Cs-137	8.29E-01	7.96E-01	9.57E-01
Eu-152	5.49E-03	2.97E-03	9.56E-03
Eu-154	2.81E-03	4.04E-03	3.42E-03
Sum	1.0	1.0	1.0

6.14.2. Surrogate Radionuclide Ratio

The FSS will be performed using gamma spectroscopy. The ROC include one radionuclide that is not a gamma emitter, i.e., Sr-90. As discussed in LTP Chapter 5, the Sr-90 concentration will be accounted for using a surrogate approach during FSS. The ratio of Sr-90/Cs-137 from the site radionuclide mixture is required to implement the surrogate approach.

The Sr-90/Cs-137 surrogate is calculated separately for the Reactor Building, WGTV, and soil in section 6.4 of Reference (5) using applicable core data. When Sr-90 was not detected, the MDC was assigned. The result of one core sample was non-detect for both Cs-137 and Sr-90. The ratio of the MDC's is not used since this is merely a ratio of the detectability of the two nuclides for that specific sample and has no relationship to the activity ratio. The 95th percentile of the data sets are assigned as the surrogate ratios for use during FSS as listed in Table 6-20.

Table 6-20 Sr-90 to Cs-137 Surrogate Ratios to be applied during FSS (95th Percentile values)

Building or Area	Sr-90/Cs-137 Surrogate Activity Ratio
WGTV	6.75E-02
Reactor Building	5.00E-01
Soil[1]	5.02E-01

Note 1: The soil designation represents all concrete core bores and can also be used for other miscellaneous structures to remain if needed.

6.15. BFM Groundwater Scenario Mixing Volume Sensitivity Analysis for ROC

The BFM $DCGL_{gw}$ are based on a conceptual model that assumes instant release of all activity and uniform mixing throughout the entire fill volume. The concentration in fill is a function of the mixing volume which is proportional to the distance away from the wall that the released activity is assumed to mix. The fill concentration increases with decreasing mix distance but the source term geometries, and dose per pCi/g in fill, also change with mixing distance. A sensitivity analysis was performed for the ROC to evaluate the impact of mixing distance on the dose from the BFM Groundwater scenario. Mixing distance does not impact the dose from the BFM Drilling Spoils scenario which assumes all activity remains in the concrete.

The mixing distance sensitivity analyses for the BFM Groundwater scenario were performed assuming that released activity mixes over distances of 1 m, 2 m, and 3 m from the floor and wall surfaces, as opposed to full mixing. A mixing distance of 1 m was assumed to conservatively represent a minimum width from which a well drawdown zone would not include dilution with adjacent, uncontaminated, groundwater.

Separate analyses were performed for the Reactor Building and the WGTV. For the WGTV, three fill mixing geometries were evaluated including; 1) mixing in fill adjacent to the two walls perpendicular to groundwater flow, 2) mixing in fill adjacent to a wall parallel to groundwater flow, and 3) mixing in fill adjacent to the floor. RESRAD modeling was performed with the deterministic parameters used to calculate the BFM $Insitu_{gw}$ DCGLs (see section 6.11.1) but

changing the source term parameters to represent the three mixing geometries, for 1, 2, and 3 m distances as shown in Table 6-21.

Table 6-21 WGTV Mixing Sensitivity RESRAD Source Term Geometries

Parameter	Mixing Distance	Perpendicular Walls	Parallel Wall	Floor
Area of Contaminated Zone (m^2)	1	18	9.6	86.4
	2	36	19.2	86.4
	3	54	28.8	86.4
Thickness of Contaminated zone (m)	1	4.57	4.57	1
	2	4.57	4.57	2
	3	4.57	4.57	3
Length Parallel to Aquifer Flow (m)	1	2	9.6	9.6
	2	4	9.6	9.6
	3	6	9.6	9.6

The values in Table 6-21 are directly related to the WGTV structure geometry with the exception of the values listed for the perpendicular walls. There are two walls perpendicular to groundwater flow and the activity in each wall is assumed to mix in the layer of fill immediately adjacent to the wall. The fill layers from each of the two perpendicular walls are assumed to be contiguous resulting in a length parallel to flow of 2 times the mixing distance.

The Reactor Building is circular as opposed to rectangular. Therefore, there is no geometry equivalent to the Parallel Wall geometry in the WGTV. The Perpendicular Walls and Floor geometries were evaluated. The Reactor Building mix sensitivity source term geometries for 1, 2, and 3 m distances are provided in Table 6-22.

Table 6-22 Reactor Building Mixing Sensitivity RESRAD Source Term Geometries

Parameter	Mixing Distance	Perpendicular Walls	Floor
Area of Contaminated Zone (m^2)	1	102.34	262.68
	2	179.55	262.68
	3	231.62	262.68
Thickness of Contaminated zone (m)	1	7.32	1
	2	7.32	2
	3	7.32	3
Length Parallel to Aquifer Flow (m)	1	2	18.29
	2	4	18.29
	3	6	18.29

The RESRAD Summary Reports for the analyses of the 15 mixing sensitivity geometries in Table 6-21 and Table 6-22 are provided electronically in Reference (8).

The impact of mixing distance on dose was evaluated by calculating the ratio of the dose factor (mrem/year per pCi/m^2) for each partial mixing distance (1, 2, and 3 m) to the dose factor under the full mixing assumption. The maximum values of the ratios of Partial/Full mixing dose, for all ROC, and all 15 geometries listed in Table 6-21 and Table 6-22 are provided in Table 6-23. The dose from the perpendicular wall and floor geometries were summed, for each partial mixing distance, to determine the maximum ratio because both the floor and perpendicular wall fill

source terms can contribute to a well simultaneously under partial mixing. The parallel wall source term (WGTV only) includes the fill from the top of the wall down to the floor. The residual radioactivity in the floor is therefore included in the calculation of fill concentration. The well is assumed to be placed at the downstream edge of the parallel wall source term.

Table 6-23 Mixing Sensitivity Analysis Results Summary Maximum Ratio of Dose Factor Partial Mix/Full Mix

ROC	Rx Building Wall + Floor	WGTV Wall + Floor
Co-60	1.25	1.19
Cs-137	1.91	1.42
Sr-90	1.08	1.18
Eu-152	2.03	1.41
Eu-154	2.03	1.40

To ensure a conservative and bounding $DCGL_{gw}$ for ROCs in backfilled basement surfaces, the $DCGL_{gw}$ values calculated for each ROC under the full mixing assumption (Table 6-12) were reduced by the ratios in Table 6-23 (see section 6.16).

6.16. BFM DCGLs for ROC Adjusted for Insignificant Contributor Dose and Mixing Sensitivity

The $DCGL_{BS}$ for each ROC, each basement, and each dose scenario, are adjusted for the IC dose percentage of 10% and mixing sensitivity. The adjusted $DCGL_{BS}$ are calculated using Equation 6-10.

Equation 6-10

$$DCGL_{BS,i}\ GW = \frac{BFM\ Insitu_{gw,i}\ DCGL * IC\ Dose\ Adjust}{MS\ Ratio_i}$$

$$DCGL_{BS,i}\ DS = BFM\ Insitu_{ds,i}\ DCGL * IC\ Dose\ Adjust$$

$$DCGL_{BS,i}\ Excavation = BFM\ Excavation\ DCGL_i * IC\ Dose\ Adjust$$

Where:

$DCGL_{BS,i}$ GW	= BFM Insitu Groundwater, for ROC (i), adjusted for IC dose and mixing sensitivity
BFM $Insitu_{gw,i}$ DCGL	= BFM $Insitu_{gw}$ DCGL, for ROC (i), from Table 6-12
IC Dose Adjust	= Insignificant contributor adjustment factor of 0.9 (equal to 1.0 minus the assigned IC dose of 0.1)
MS $Ratio_i$	= Maximum Mixing Sensitivity ratio, for ROC (i), from Table 6-23
$DCGL_{BS,i}$ DS	= $DCGL_{BS}$, for ROC (i), adjusted for IC dose.
BFM $Insitu_{ds,i}$ DCGL	= BFM $Insitu_{ds}$ DCGL, for ROC (i), from Table 6-13
$DCGL_{BS,i}$ Excavation	= BFM Excavation DCGL, for ROC (i), adjusted for IC dose
BFM Excavation $DCGL_i$	= BFM Excavation DCGL, for ROC (i), from Table 6-15

The ROC DCGLs were also adjusted to account for the maximum Resident Gardener Alternate Scenario dose of 28.4 mrem/yr and 34.9 mrem/yr for the Reactor Building and WGTV,

respectively (see section 6.18.2). The Alternate Scenario adjustment was made by multiplying the DCGLs by additional factors of 0.88 (=25/28.4) and 0.72 (=25/34.9) for the Reactor Building and WGTV, respectively. The results are provided in Table 6-24 and Table 6-25.

Table 6-24 Reactor Building BFM DCGLs for ROC Individual BFM Scenarios ($DCGL_{BS}$) Adjusted for Insignificant Contributor Dose Fraction, Mixing Sensitivity and Alternate Scenario Dose

ROC	Reactor Building Adjusted BFM $DCGL_{BS}$ (pCi/m^2)		
	Insitu GW	Insitu Drilling Spoils	Excavation
Co-60	1.21E+08	4.75E+08	5.45E+06
Sr-90	1.46E+07	2.70E+11	2.80E+09
Cs-137	1.98E+08	1.94E+09	2.47E+07
Eu-152	2.73E+09	1.00E+09	1.21E+07
Eu-154	1.88E+09	9.43E+08	1.12E+07

Table 6-25 WGTV BFM DCGLs for ROC Individual BFM Scenarios ($DCGL_{BS}$) Adjusted for Insignificant Contributor Dose Fraction, Mixing Sensitivity and Alternate Scenario Dose

ROC	WGTV Adjusted BFM $DCGL_{BS}$ (pCi/m^2)		
	Insitu GW	Insitu Drilling Spoils	Excavation
Co-60	6.23E+07	3.86E+08	4.43E+06
Sr-90	6.42E+06	2.20E+11	2.28E+09
Cs-137	1.52E+08	1.58E+09	2.01E+07
Eu-152	2.28E+09	8.16E+08	9.84E+06
Eu-154	1.57E+09	7.67E+08	9.12E+06

The DCGLs to be used for compliance during the FSS of basements (the MARSSIM $DCGL_w$ value) are the $DCGL_B$ values which represent the summation of the dose from the three scenarios. The adjusted $DCGL_B$ values for each ROC and each basement are calculated using Equation 6-6 with the adjusted $DCGL_{BS}$ values in Table 6-24 and Table 6-25. The results are provided in Table 6-26.

Applying the $DCGL_B$ values for compliance is conservative since the summation includes dose from the BFM Insitu scenarios and the BFM Excavation scenario which are mutually exclusive. The concrete can either be in the as-left backfilled configuration or excavated but not both simultaneously.

Table 6-26 BFM $DCGL_B$ Values for ROC Adjusted for Insignificant Contributor Dose Fraction and Alternate Scenario Dose

	Rx Bldg $DCGL_B$ (pCi/m^2)	WGTV $DCGL_B$ (pCi/m^2)
Co-60	5.16E+06	4.10E+06
Sr-90	1.45E+07	6.40E+06
Cs-137	2.17E+07	1.76E+07
Eu-152	1.19E+07	9.69E+06
Eu-154	1.10E+07	8.97E+06

6.16.1. Soil DCGLs for ROC Adjusted for Insignificant Contributor Dose and Alternate Scenario Dose

As discussed in 6.14.1, the IC dose percentage assigned to soil is 10%. The soil DCGLs for the ROC are adjusted for the IC dose by multiplying the DCGLs in Table 6-6 by a factor of 0.9 which is calculated as 1.0-0.10 = 0.90. The ROC DCGLs were also adjusted to account for the maximum Resident Gardener Alternate Scenario soil dose of 27.07 mrem/yr (see section 6.18.1) by multiplying the DCGLs by an additional factor of 0.92 (25/27.07).

The adjusted soil DCGLs for each ROC are provided in Table 6-27.

Table 6-27 Soil DCGLs for ROC Adjusted for Insignificant Contributor Dose and Alternate Scenario Dose

ROC	Adjusted Soil DCGLs (pCi/g)
Co-60	1.06E+01
Sr-90	5.47E+03
Cs-137	4.83E+01
Eu-152	2.36E+01
Eu-154	2.19E+01

6.17. Concentrations in Excavated Fill Material

A check calculation is performed in Reference (8) to determine the maximum hypothetical concentrations of the ROC in fill material after excavation. The calculation assumes that 100% of the residual radioactivity in the concrete is instantly released to the fill and uniformly mixed in the fill during basement excavation. Therefore, the source term would be in the fill and not in the concrete. The calculation is performed for each ROC separately and assumes that the residual radioactivity is uniformly distributed over basement surfaces at the BFM $DCGL_B$.

Consistent with the discussion in section 6.12 regarding the excavation of concrete, the concentrations in the fill are calculated for two excavation and mixing scenarios; 1) full excavation of the fill and mixing of all activity in concrete (100% release) with all of the fill in the basement, and 2) partial excavation of fill and mixing of all activity in concrete (100% release) with the fill adjacent to the concrete that is excavated. The concentration in fill subject to partial excavation is calculated assuming that the minimum mixing volume is 1 m^3 based on a

typical fill excavation process which entails using a 1.0 to 1.5 cubic yard bucket (see discussion in section 6.12). The partial excavation fill concentration is calculated assuming that all of the activity in a 1 m^2 concrete surface area is captured and mixed in a single 1 m^3 bucket load (1 m distance from a 1 m^2 surface). To ensure conservatism, several worst-case bucket loads are assumed to be stockpiled together such that area over which the excavated fill is spread results in a soil AF of 1. A single bucket load would have an AF >1.

The fill concentrations for the Full and Partial excavation assumptions are provided in Table 6-28. The partial mix fill concentration for the WGTV are slightly less than the full mix concentrations. This is due to the relatively small size of the WGTV and the presence of a center wall and concrete tank support structures which result in a slightly greater ratio of surface area to fill volume for full mix as compared to the 1/1 ratio assumed for partial mix.

Table 6-28 Maximum Fill Concentration for Full and Partial Mix

Radionuclide	Soil DCGL (pCi/g)	Reactor Building		WGTV	
		Full Mix (pCi/g)	Partial Mix (pCi/g)	Full Mix (pCi/g)	Partial Mix (pCi/g)
Co-60	1.06E+01	1.15E+00	3.33E+00	3.31E+00	3.25E+00
Sr-90	5.47E+03	3.23E+00	9.37E+00	5.18E+00	5.08E+00
Cs-137	4.83E+01	4.83E+00	1.40E+01	1.42E+01	1.39E+01
Eu-152	2.36E+01	2.65E+00	7.69E+00	7.83E+00	7.69E+00
Eu-154	2.19E+01	2.45E+00	7.11E+00	7.25E+00	7.12E+00

The fill concentrations from the two excavation scenarios are compared to the adjusted soil DCGLs from Table 6-27. For all ROC and both basements, the hypothetical maximum fill concentrations are less than the respective soil DCGLs. Therefore, if all activity in basement surfaces is instantly released, mixed with the fill, and excavated, the dose from the fill material would always be less than the dose assigned using BFM $DCGL_B$ values.

6.18. Alternate Land Use Scenario Dose

Two alternate "less likely but plausible" land use scenarios were considered, Resident Gardener with onsite well and Recreational Use with onsite well. In accordance with NUREG-1757, these less likely but plausible scenarios were not analyzed for compliance, but were used to risk-inform the decision of Industrial Use as the "reasonably foreseeable" land use. NUREG-1757 states that if the peak dose from a less likely put plausible scenario is "significant" then greater assurance that the scenario is unlikely would be necessary.

A quantitative evaluation of the dose from the Recreational Use scenario was not required. A simple qualitative evaluation concluded that the dose than the Recreational Use scenario will be less than the dose from the Industrial Use scenario because the occupancy time and well water intake rate would be less.

A dose assessment of the Resident Gardener scenario (with onsite well for drinking water and irrigation) was performed. The Resident Gardener pathways included direct dose, inhalation, soil ingestion and fruit and vegetables from an onsite garden. It was considered highly unlikely that livestock would be raised on the site so the meat and milk pathways were inactive.

The alternate scenario dose assessment was performed for soil, for the *in situ* geometry of two backfilled basements to remain (Reactor Building and WGTV), and for the excavation of concrete (and fill) from the basements. The doses were calculated assuming that a resident gardener could not plausibly occupy the LACBWR site until after the G-3 plant ceased operation and was decommissioned which was conservatively assumed to be 30 years after license termination.

The full initial suite of radionuclides was evaluated to determine the dose from the IC radionuclides specifically for the Resident Gardener scenario. The Resident Gardener dose was calculated using the ROC (which are the same as selected for the Industrial Use scenario), after adjusting the ROC for the Resident Gardener-specific IC dose. The dose was calculated in Reference (5) using a source term based on the conservative radionuclide mixture in Table 6-3.

6.18.1. Resident Gardener Dose: Soil

The RESRAD assessment of Resident Gardener dose from soil applied the Industrial Use deterministic parameters in Attachment 6-1 with nine parameter changes or additions as listed in Table 6-29. The contaminated zone thickness was changed to 0.15 m to more closely represent actual site conditions as opposed to the 1 m depth assumed in the screening approach applied in the Industrial Use scenario. The remaining parameters in Table 6-29 are metabolic and behavioral. The reference or basis for the selected parameters are also listed in Table 6-29.

Table 6-29 Additions/Revisions to Industrial Use Parameters Required for Resident Gardener Scenario

Parameter	Value	Basis
Contaminated Zone Thickness	0.15 m	Standard surface soil contamination depth assumption and consistent with expected site conditions
Inhalation Rate	8400 m^3/yr	NUREG/CR-5512, Vol. 3 Table 6.29 (23 m^3/d x 365 d)
Fraction of Time Spent Indoors	0.649	NUREG/CR-5512, Vol. 3 Table 6.87
Fraction of Time Spent Outdoors	0.124	NUREG/CR-5512, Vol. 3 Table 6.87 (outdoors + gardening)
Fruit, Vegetable and Grain Consumption	112 kg/yr	NUREG/CR-5512, Vol. 3 Table 6.87 (other vegetables + fruits + grain)
Leafy vegetable Consumption	21.4 Kg/yr	NUREG/CR-5512, Vol. 3 Table 6.87
Drinking Water Intake	478 L/yr	NUREG/CR-5512, Vol. 3 Table 6.87
Well Pumping Rate	530 m^3/yr	NUREG/CR-6697, Att. C Section 3.10 method assuming 7500 m^2 land area and Wisconsin irrigation rate.
Plant Food Contaminated Fraction	1	All plant food assumed to be grown onsite

An uncertainty analysis was performed specifically for the soil Resident Gardener Scenario including all radionuclides in the initial suite. The process outlined in Figure 6-7 was used to perform the uncertainty analysis and to select deterministic parameters for each radionuclide in

the initial suite. Attachment 6-3 lists the deterministic parameters and PDFs used for the uncertainty analysis.

A separate uncertainty analysis was performed for each radionuclide, ignoring the effect of radionuclide mixture fractions. This conservatively ensures that all sensitive parameters are identified for low abundance radionuclides regardless of actual impact on total dose given the mixture. The results of the uncertainty analyses are provided in Table 6-30 and Table 6-31.

Resident Gardener "Alternate Scenario DCGLs" for soil (pCi/g per 25 mrem/yr) were calculated for each initial suite radionuclide using the deterministic parameters in Attachment 6-3 with the PDFs replaced by the deterministic values from Table 6-30 and Table 6-31. The Plant Transfer Factors for all initial suite radionuclides were conservatively assigned the 75th percentile of the NUREG-6697 distribution.

The IC dose was determined specifically for the soil Resident Gardener scenario. The 75th percentile probabilistic radionuclide mixture in Table 6-3 was used in the analysis. The IC dose calculation is provided in Reference (8). The Resident Gardener ROC DCGLs were adjusted to account for the Resident Gardener-specific soil IC dose which was 0.31% of the 25 mrem/yr dose limit.

Two soil source terms were used to calculate the Resident Gardener dose. The first source term is comprised of the maximum ROC soil concentrations identified during characterization and was used to provide the most accurate estimate of dose from soil in the Resident Gardener scenario. The second source term is comprised of the ROC soil concentrations corresponding to 25 mrem/yr (i.e., the hypothetical maximum concentrations) that are calculating using the IC adjusted Industrial Use soil DCGLs, the 75th percentile radionuclide mixture (Table 6-3), and the unity rule.

The dose calculations are provided in Reference (8). The soil dose from the Resident Gardener alternate scenario using the maximum concentrations identified during characterization as the source term is 1.13 mrem/yr. When the source term was the hypothetical maximum soil concentrations that could remain given the Industrial Scenario DCGLs, the dose is 27.07 mrem/yr.

The calculation of the soil DCGLs reported in Table 6-27 includes an adjustment to ensure that the Alternate Scenario soil dose does not exceed 25 mrem/yr.

Table 6-30 Soil Alternate Scenario Resident Gardener Uncertainty Analysis Results and Deterministic Values Selected for Non-Nuclide Specific Parameter Distributions

Parameter	Correlation to Dose[1]	Radionuclide	Basis of Deterministic Parameter Selection	Selected Deterministic Value
Contaminated zone erosion rate	Negative	Ni-59, Ni-63, Pu-241	25th	7.6E-04
Contaminated zone b parameter	NS	NA	median	0.97
Evapotranspiration coefficient	Positive	Tc-99	75th	0.69
Wind Speed	Negative	C-14	25th	3.6
Runoff coefficient	Positive	H-3, Tc-99	75th	0.62
Well pump intake depth	NS	NA	mode	21.2
b Parameter of Unsaturated zone	NS	NA	median	0.97
Mass loading for inhalation	NS	NA	median	2.35E-05
Indoor dust filtration factor	NS	NA	median	0.55
External gamma shielding factor	Positive	Co-60, Nb-94, Cs-137, Eu-152, Eu-154, Eu-155, Am-243, Cm-243	75th	0.4
Depth of Soil Mixing Layer	Negative	Fe-55, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cm-243, Cm-244	25th	0.15
Depth of roots	Negative	H-3, Fe-55, Ni-59, Ni-63, Sr-90, Tc-99, Cs-137, Np-237, Pu-238, Pu-239.Pu-240, Pu-241, Am-241, Am-243, Cm-243, Cm-244	25th	1.22
Wet weight crop yield of fruit, grain, and non-leafy vegetables	NS	NA	median	1.75
Weathering removal constant for all vegetation	NS	NA	median	33
Wet foliar interceptions fraction of leafy vegetables	NS	NA	median	0.58

(1) NS = Not Sensitive

Table 6-31 Soil Alternate Scenario Resident Gardener Uncertainty Analysis Results for Distribution Coefficients (K_d) and Deterministic Values Selected

Radionuclide	Kd in Contaminated Zone, Unsaturated Zone and Saturated Zone (cm^3/mg)	
H-3	NS	0.06
C-14	NS	5
Fe-55	NS	220
Ni-59	NS	400
Co-60	NS	60
Ni-63	NS	400
Sr-90	NS	15
Nb-94	NS	160
Tc-99	NS	0.1
Cs-137	NS	280
Eu-152[1]	NS	825
Eu-154[1]	NS	825
Eu-155[1]	NS	825
Np-237	NS	5
Pu-238	NS	550
Pu-239/240	NS	550
Pu-241	NS	550
Am-241	NS	1900
Am-243	NS	1900
Cm-243/244	NS	4000

Note 1: Sand Kds not listed in NUREG-6607 Table 3.9-2 for Europium.
The mean value from NUREG-6697, Table 3.9-1 was used.

6.18.2. Resident Gardener Dose: Reactor Building and WGTV

The Resident Gardener dose was also calculated using the backfilled Reactor Building and WGTV basement concrete as the source terms. As for soil, the Resident Gardener scenario is assumed to occur after 30 years. The dose assessment includes the three BFM dose scenarios, Insitu Groundwater, Insitu Drilling Spoils, and Excavation.

6.18.2.1. Resident Gardener Dose: Basement Insitu Groundwater

This section provides the Resident Gardener dose from the basement Insitu Groundwater scenario and maximum hypothetical radionuclide concentrations.

An uncertainty analysis was performed specifically for the Reactor Building and WGTV as source terms using the Resident Gardener Scenario parameter set. All radionuclides in the initial suite were included. The uncertainty analysis process outlined in Figure 6-7 was followed.

Attachment 6-3 provides the deterministic parameters and PDFs used for the uncertainty analysis. Certain parameters in Attachment 6-3, as listed below, relating to the geometry of each

basement were changed to the deterministic values listed in Table 6-7. The affected RESRAD geometry parameters are:

- cover depth,
- area of contaminated zone,
- thickness of contaminated zone,
- length parallel to aquifer flow, unsaturated zone thickness, and
- contaminated fraction below the water table.

A separate uncertainty analysis was performed for each initial suite radionuclide, ignoring the effect of radionuclide mixture fractions. This conservatively ensures that all sensitive parameters are identified for low abundance radionuclides regardless of actual impact on total dose given the mixture.

The RESRAD Uncertainty Reports for the Reactor Building and WGTV Resident Gardener scenario were submitted electronically with Reference (8). The results of the uncertainty analyses are provided in Table 6-32 and Table 6-33.

The Kds were negatively correlated for all but two radionuclides, Tc-99 and Nb-94. The absolute values of the PRCC were less than the |0.25| threshold for a number of radionuclides. However, A cross-check with the SRRC in the uncertainty analysis report indicates that the correlation may be more significant than indicated by the PRCC. A sensitivity analysis was performed using the 25th percentile Kds and the median Kds for the radionuclides with PRCC < |0.25|. The 25th percentile Kds resulted in higher dose for the negatively correlated radionuclides and were therefore assigned to all negatively correlated radionuclides. The cause of the positive correlation to the Tc-99 Kd was the effect on the plant dose, primarily the water independent pathway. The 75th percentile Kd resulted in the highest dose and was assigned to Tc-99. The cause of the positive correlation to the Nb-94 Kd was found to be direct dose from the water independent pathway after long term cover erosion. The maximum Nb-94 dose occurs when the 75th percentile Kd is applied but the time of maximum dose is year 312. This result is due to the unique decay characteristics of Nb-94 which include gamma emission with a very long half-life. The 75th percentile Kd was applied for Nb-94 to ensure conservatism.

Resident Gardener "Alternate Scenario Basement Groundwater DCGLs" (pCi/g per 25 mrem/yr) were calculated for each initial suite radionuclide using the deterministic parameters in Attachment 6-3, with the PDFs replaced by the deterministic values from Table 6-32 and Table 6-33 and the basement geometry parameters replaced by the values in Table 6-7. The Plant Transfer Factors for all initial suite radionuclides were conservatively assigned the 75th percentile of the NUREG-6697 PDF.

The RESRAD Summary Reports for the Reactor Building and WGTV alternate scenario dose assessment were submitted electronically with Reference (8).

The IC dose is calculated specifically for the Insitu Groundwater Reactor Building and WGTV using the "Alternate Scenario Groundwater DCGLs". The Resident Gardener scenario-specific IC dose calculations and inputs are provided in Reference (5). The Resident Gardener-specific IC doses for the Reactor Building and WGTV are 7.0% and 14.1%, respectively, and the "Alternate Scenario Groundwater DCGLs" were adjusted using these values.

The Resident Gardener dose is calculated separately for the Reactor Building and WGTV using the "Alternate Scenario Groundwater DCGLs" for ROC (adjusted for the Resident Gardener-specific IC dose). The radionuclide concentrations used for the calculation were the maximum values in concrete that would be allowed to remain in each basement under the BFM Industrial Use scenario. The maximum concentrations are those corresponding to 25 mrem/yr using the BFM $DCGL_B$ values for ROC in Table 6-16 (adjusted for IC dose percentage of 10%), the 75th percentile mixture in Table 6-3, and the unity rule to account for all ROC contributions. The calculation of the maximum concentrations and Resident Gardener dose are provided in Reference (8).

The Resident Gardener Insitu Groundwater doses, after 30-year decay, for the Reactor Building and WGTV are 7.51 mrem/yr and 8.72 mrem/yr, respectively.

6.18.2.2. Resident Gardener Dose: Basement Drilling Spoils

This section provides the Resident Gardener dose from the Reactor Building and WGTV basements Insitu Drilling Spoils scenario.

The Resident Gardener dose from the drilling spoils scenario is calculated using the methods described in 6.11.2 but replacing the Industrial Use soil DCGLs, and the 0.457 m^2 soil area factors, with corresponding Resident Gardener "Alternate Scenario Soil DCGLs" and area factors. The RESRAD Summary report for the area factors is provided electronically with Reference (8). The "Alternate Scenario Basement Drilling Spoils DCGLs" for the ROC were adjusted for IC dose using a conservative assumption that the IC dose percentage was 10% as was used for the BFM Drilling spoils adjustment. The actual IC dose is expected to be the same as that calculated for the Resident Gardener soil scenario (i.e., 0.35%). The radionuclide concentrations applied in the Insitu Drilling Spoils Resident Gardener dose assessment were the same maximum allowable ROC concentrations that were calculated in section 6.18.2.1. The details of the alternate scenario drilling spoils dose calculation are provided in Reference (8).

The Resident Gardener Insitu Drilling Spoils doses (after 30-year decay) for the Reactor Building and WGTV are 0.25 mrem/yr and 0.35 mrem/yr, respectively.

Table 6-32 BFM Insitu$_{gw}$ Alternate Scenario Resident Gardener Uncertainty Analysis Results and Deterministic Values Selected for Non-Nuclide Specific Parameter Distributions

Parameter	Correlation to Dose[1]	Radionuclide		Basis of Deterministic Parameter Selection	Selected Deterministic Value
		Rx Building	WGTV		
Cover erosion rate	Positive	Ni-59, Nb-94, Pu-241, Pu-239, Am-241	Ni-59, Ni-63, Nb-94. Pu-239, Pu-241, Am-241	75th	2.9E-03
Contaminated zone b parameter	NS	NA	NA	median	0.97
Contaminated Zone Erosion Rate	NS	NA	NA	median	0.00015
Evapotranspiration coefficient	Positive (Rx Building) NS (WGTV)	H-3		75th (Rx Building) Median (WGTV)	0.69 (Rx Building) 0.62 (WGTV)
Wind Speed	NS	NA	NA	median	3.6
Runoff coefficient	Positive (Rx Building) NS (WGTV)	H-3		75th (Rx Building) Median (WGTV)	0.62 (Rx Building) 0.45 (WGTV)
Well pump intake depth	Negative	H-3, C-14, Fe-55, Sr-90, Np-237, Pu-241, Pu-239	H-3, C-14, Fe-55, Sr-90, Np-237, Pu-239	Minimum Depth	6.1
b Parameter of Unsaturated zone	NS	NA	NA	median	0.97
Mass loading for inhalation	NS	NA	NA	median	2.35E-05
Indoor dust filtration factor	NS	NA	NA	median	0.55
External gamma shielding factor	NS	NA	NA	median	0.4
Depth of Soil Mixing Layer	NS	NA	NA	median	0.15
Depth of roots	Positive	C-14, Fe-55, Co-60, Ni-59, Ni-63, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, Eu-155, Np-237, Pu-241, Pu-239, Am-241	H-3, C-14, Fe-55, Ni-59, Co-60, Ni-63, Sr-90, Tc-99, Cs-137, Eu-152, Eu-154, Eu-155, Np-237, Pu-239, Pu-241, Am-241	75th	3.07
Wet weight crop yield of fruit, grain, and non-leafy vegetables	NS	NA	NA	median	1.75
Weathering removal constant for all vegetation	NS	NA	NA	median	33
Wet foliar interceptions fraction of leafy vegetables	NS	NA	NA	median	0.58

Note 1: NS= Not Sensitive

Table 6-33 BFM Insitu$_{gw}$ Alternate Scenario Resident Gardener Uncertainty Analysis Results for Distribution Coefficients (K_d) and Deterministic Values Selected

Radionuclide	Rx Building Kd in Contaminated Zone and Saturated Zone (cm^3/mg)		WGTV Kd in Contaminated Zone and Saturated Zone (cm^3/mg)	
H-3	Negative[1]	0.05	Negative[1]	0.05
C-14	Negative	1.8	Negative	1.8
Fe-55	Negative	38	Negative	38
Ni-59	Negative	147	Negative	147
Co-60	Negative	9	Negative	9
Ni-63	Negative	147	Negative	147
Sr-90	Negative	5	Negative	5
Nb-94	Positive[1]	611	Negative	611
Tc-99	Positive	0.46	Positive[1]	0.46
Cs-137	Negative	50	Negative	50
Eu-152[2]	Negative	95	Negative	95
Eu-154[2]	Negative	95	Negative	95
Eu-155	Negative	95	Negative	95
Np-237	Negative	1	Negative	1
Pu-238	Negative	173	Negative	173
Pu-239/240	Negative	173	Negative	173
Pu-241	Negative	173	Negative	173
Am-241	Negative	329	Negative	329
Am-243	Negative	329	Negative	329
Cm-243/244	Negative	881	Negative	881

Note 1: 25th and 75th percentile values for sand from Reference (8) (see Attachment 3)
Note 2: Sand Kds not listed in NUREG-6697 Table 3.9-2 for Europium. The mean

6.18.2.3. Resident Gardener Dose: Basement Concrete Excavation Scenario

This section provides the Resident Gardener dose from the Reactor Building and WGTV basement Excavation scenarios.

The BFM Industrial Use Excavation DCGLs are derived by limiting the concentrations in the excavated concrete to the concentrations of the Industrial Use soil DCGLs (see section 6.12). To calculate the Resident Gardener dose from excavated concrete, the BFM Excavation DCGLs in Table 6-15 are multiplied by the ratio of the Industrial Use Soil DSR to the Resident Gardener "Alternate Scenario Soil DSR". Note that the "Alternate Scenario Soil DSR" are adjusted for Resident Gardener-specific IC dose as discussed in section 6.18.1. The "Alternate Scenario Excavation DCGLs" are used to calculate the Resident Gardener dose from excavated basement concrete using the maximum concrete ROC concentrations hypothetically allowed by the Industrial Use scenario as discussed in section 6.18.2.1. The concrete excavation dose calculations are provided in Reference (8).

The Resident Gardener Concrete Excavation dose (after 30-year decay) for the Reactor Building and WGTV are 20.7 mrem/yr and 25.9 mrem/yr, respectively.

6.18.2.4. Total Resident Gardener Alternate Scenario Dose: Reactor Building and WGTV

The total Resident Gardener doses from the Reactor Building and WGTV are calculated by summing the dose from the Insitu Groundwater, Insitu Drilling Spoils and Excavation scenarios. The Total Resident Gardener doses from the Reactor Building and WGTV, assuming maximum allowable concentrations in the basement concrete, are 28.4 mrem/yr and 34.9 mrem/yr, respectively. To ensure conservatism, the BFM $DCGL_{BS}$ and $DCGL_{B}$ values reported in Table 6-24, Table 6-25, and Table 6-26 include an adjustment to ensure that the Alternate Scenario dose does not exceed 25 mrem/yr.

6.18.2.5. Resident Gardener Dose from Excavated Basement Fill

The Resident Gardener dose was also calculated using the maximum hypothetical fill concentrations in the Reactor Building and WGTV (see section 6.17). The doses from excavated fill (after 30-year decay) were 6.3 mrem/yr and 8.0 mrem/yr for the Reactor Building and WGTV, respectively (8).

6.18.2.6. Conclusion: Resident Gardener Alternate Scenario Dose

The Resident Gardener dose, after 30 years decay, was evaluated for soil and basements. The maximum soil dose is 27.07 mrem/yr. The maximum basement doses are 28.4 mrem/yr and 34.9 mrem/yr, for the Reactor Building and WGTV, respectively. These doses are not considered significant and therefore greater assurance that these scenarios will not occur is not necessary. However, adjustments were made to the soil and basement DCGLs to ensure that no Alternate Scenario dose exceeds 25 mrem/yr.

6.19. Soil Area Factors

The RESRAD modeling for soil assumes that the entire area within the LSE, 7500 m^2, is contaminated. Isolated areas of contamination that are smaller than 7500 m^2 will have a lower dose for a given concentration. The ratio of the dose from the full source term area to the dose from a smaller area is defined as the AF.

Reference (8) calculates AFs for each ROC using RESRAD with the deterministic parameter set used to calculate soil DCGLs. The "Area of Contaminated Zone" parameter was varied from 1.0 m^2 to 100 m^2. The need to apply AFs to contaminated areas greater than 100 m^2 is unlikely. The AFs were calculated by dividing the pCi/g per 25 mrem/yr value from RESRAD for each smaller area by the soil DCGLs in Table 6-7. The full RESRAD Summary Reports are provided electronically with Reference (8). The AFs are provided in Table 6-34.

Table 6-34 Surface Soil Area Factors

Radionuclide	Area Factors				
	$1m^2$	$2m^2$	$5m^2$	$10m^2$	$100m^2$
Cs-137	9.44	5.56	3.07	2.04	1.19
Co-60	9.11	5.42	3.01	2.00	1.18
Sr-90	11.21	6.66	3.69	2.45	1.41
Eu-152	9.30	5.50	3.04	2.02	1.18
Eu-154	9.38	5.54	3.06	2.03	1.18

6.20. Buried Piping Dose Assessment and DCGL

Buried piping is defined as below ground pipe located outside of structures and basements. This section describes the buried pipe dose assessment methods and provides the resulting DCGLs. The calculations are performed by RESRAD and Excel spreadsheet as detailed in Reference (8).

6.20.1. Source Term and Radionuclide Mixture

With the exception of a portion of the Circulating Water System Pipe, none of the buried piping to remain at LACBWR was associated with contaminated systems and therefore contamination potential is minimal. See Table 6-2 for list of buried pipe to remain. The High Pressure Service Water from LACBWR Crib House to G-3 and Well water piping for Well #3 are considered non-impacted because they only contacted clean river water or groundwater with no potential for contamination and will continue operation after license termination.

DCGLs for buried pipe were calculated for the initial suite radionuclides. To date, no characterization has been performed in buried piping due to the very low contamination potential. The radionuclide mixture is assumed to be the same as listed in Table 6-3. As discussed in LTP Chapter 5, if continuing characterization is performed for buried pipe and the results indicate that the buried piping dose could exceed 50% of the 25 mrem/yr dose criterion, then samples will be analyzed for HTD radionuclides and additional assessments performed.

6.20.2. Exposure Scenario and Critical Group

The dose assessment approach was generally consistent with the guidance in NUREG-1757, Appendix J in that two exposure scenarios were considered; 1) assuming that the buried pipe is excavated and spread across the surface (Excavation scenario), and 2) assuming that the buried pipe remains in situ (Insitu scenario).

NUREG-1757, Appendix J states that it should be appropriate to use the arithmetic average of the radionuclide concentration in the analysis, including any interspersing clean soil. The buried piping at LACBWR is a minimum of 1 m below grade. The LACBWR buried pipe excavation conceptual model is more conservative than the NUREG-1757, Appendix J conceptual model in that no mixing is assumed to occur with the soil in the 1 m cover or the interspersing clean soil between pipes during excavation.

The conceptual models for the buried pipe Insitu and Excavation scenarios are similar to those developed for the BFM. In the Insitu scenario, the residual radioactivity on the internal surfaces

of the pipe is assumed to instantaneously release and mix with a thin 2.54 cm layer of soil in an area equal to the internal surface area of the pipe. The Insitu scenario model assumes that the released radioactivity as a below ground 2.54 cm layer of soil with no credit taken for the presence of the pipe to reduce environmental transport and migration. This is a conservative assumption, particularly for the Circulating Water Discharge Pipe which will be filled with a flowable fill material. The Excavation scenario model assumes that the released radioactivity is mixed in a 15 cm layer of soil on the ground surface after excavation. A 15 cm mixing layer is assumed due to the extensive ground surface disturbance caused by the large scale excavation required to remove pipe. The Industrial Worker is exposed to the Insitu and Excavated soil via the same pathways applicable to the BFM and soil models.

6.20.3. Buried Piping Dose Assessment

RESRAD modeling was performed to calculate DSRs which are the basis for determining DCGLs for the internal surfaces of the pipes after converting units to dpm/100 cm^2.

The buried piping was separated into two categories. The first category included the summation and grouping of all impacted buried pipe other than the Circulating Water Discharge Piping and is designated as the "Group". The second category consisted of the Circulating Water Discharge Pipe only. The separation of the Circulating Water pipe was necessary because the geometry was significantly different from the other pipe and the pipes are located in distinctly different parts of the site.

The Insitu dose calculation for the buried piping "Group" (which as stated above does not include the Circulating Water Discharge pipe) was performed by RESRAD modeling using the input parameters applied to the BFM Insitu Groundwater scenario with adjustments to the source term geometry as listed in Table 6-35. The lowest elevation at the bottom of the Group piping is 625′ (excluding water well #3 piping which is considered non-impacted). Using the lowest elevation maximizes the Insitu dose, which is driven by the groundwater pathway, by minimizing the distance to the water table. The assumed RESRAD parameters "Area of Contaminated Zone" and "Length Parallel to Flow" were calculated assuming that the all of the pipe in the Group was located in one circular area equal in size to the summed internal surface area of all Group pipes. The internal surface area of the High-Pressure Service Water from LACBWR Crib House to G-3 Well and water piping for Well #3 are conservatively included in the calculation of total area for the Group piping notwithstanding their classification as non-impacted (i.e., no FSS to be performed).

The Insitu dose for the Circulating Water Discharge Pipe was also calculated using the BFM Insitu Groundwater parameters with the elevation of the thin contaminated layer being set at the elevation of the bottom of the pipe (630.5 foot). The Circulating Water Discharge pipe drops 10′ to 620.5′ elevation at the outfall but this 10-foot length is trivial compared to the total 525′ length at 630.5′ elevation. In addition, it is not plausible to locate a well between the location where the pipe drops and the outfall. The contaminated area was set equal to the internal surface area of the pipe.

The dose from the Excavation scenarios (and corresponding DCGLs) for both the Buried Pipe Group and the Circulating Water Discharge Pipe were calculated using the RESRAD parameters used to calculate surface soil DCGLs with source term adjustments as listed in Table 6-35.

Table 6-35 RESRAD Source Term Parameters for Buried Piping DCGL Calculations

Parameter	Buried Pipe Group Insitu	Buried Pipe Group Excavation	Circulating Water Discharge Pipe Insitu	Circulating Water Discharge Pipe Excavation
Cover Depth (m)	3.02	0	2.59	0
Area of Contaminated Zone (m^2)	1552.70	1552.70	766.14	766.14
Thickness of Contaminated zone (m)	0.0254	0.15	0.0254	0.15
Length Parallel to Aquifer Flow (m)	44.46		160.02	160.02
Unsaturated Zone Thickness (m)	0	2.90	0.43	2.90
Depth of Soil Mixing Layer	0.15	0.15	0.15	0.15

6.20.4. Buried Pipe DCGLs Initial Suite

The RESRAD Summary Reports are provided electronically with Reference (8). The detailed inputs to the DCGL calculation, including RESRAD source term parameter calculations, a list of the resulting RESRAD DSRs generated by modeling and all unit conversions are provided in Reference (8). The buried pipe DCGLs for the initial suite are provided in Table 6-36 .

6.20.5. Buried Pipe Radionuclides of Concern and Adjusted DCGLs

The Buried Pipe DCGLs in Table 6-36 were used in Reference (5) to calculate the relative dose contributions from the initial suite radionuclides, identify the IC radionuclides, select the final ROCs and adjust the ROCs for the dose fraction attributable to the removed IC radionuclides. The dose percentages for the initial suite were calculated using the mixture fractions in Table 6-3.

The dose percentages for the initial suite radionuclides were calculated using the summed DCGLs, which include the dose from the Insitu and Excavation scenarios, and the 75th percentile mixture for soil in Table 6-3. The final list of IC radionuclides was the same for all buried pipe scenarios and the same as identified for soil and basements. The ROCs are Co-60, Sr-90, Cs-137, Eu-152 and Eu-154.

The calculated IC dose percentages was 0.5% of the 25 mrem/yr dose limit for both the Group and Circulating Water Discharge Pipe. However, consistent with approach used for soil and basements, an IC dose percentage of 10% was applied to provide additional margin to account for mixture variability. Table 6-37 provides the Buried Pipe DCGLs for the ROC adjusted for the IC dose percentage.

The final DCGLs to be used during FSS account for the fact that the dose from the Insitu and Excavation scenarios must be summed in the conceptual model for buried pipe dose assessment since the insitu and excavation scenarios may occur concurrently to some extent. The summed Buried Pipe DCGLs are provided in Table 6-38.

Table 6-36 Buried Piping DCGLs

Radionuclide	Buried Pipe Group Insitu (dpm/100 cm^2)	Buried Pipe Group Excavation (dpm/100 cm^2)	Circulating Water Discharge Pipe Insitu (dpm/100 cm^2)	Circulating Water Discharge Pipe Excavation (dpm/100 cm^2)
H-3	4.59E+08	9.65E+08	1.61E+08	1.34E+09
C-14	4.65E+07	4.81E+09	2.60E+07	4.81E+09
Fe-55	1.27E+09	5.98E+10	2.03E+26	7.81E+10
Ni-59	1.15E+10	1.52E+11	2.03E+26	1.99E+11
Co-60	6.37E+06	8.44E+04	2.51E+08	8.62E+04
Ni-63	4.61E+09	5.56E+10	1.11E+11	7.26E+10
Sr-90	5.81E+05	4.03E+07	8.55E+05	4.29E+07
Nb-94	1.02E+08	1.27E+05	1.02E+08	1.29E+05
Tc-99	2.00E+07	2.41E+07	6.50E+06	3.43E+07
Cs-137	1.82E+07	3.60E+05	6.53E+08	3.67E+05
Eu-152	2.71E+08	1.82E+05	5.08E+14	1.86E+05
Eu-154	1.87E+08	1.70E+05	9.89E+17	1.73E+05
Eu-155	1.20E+09	6.62E+06	2.03E+26	6.71E+06
Np-237	6.52E+03	1.52E+04	4.34E+03	2.09E+04
Pu-238	9.79E+05	9.79E+06	6.82E+07	1.27E+07
Pu-239	8.06E+05	8.81E+06	8.15E+05	1.14E+07
Pu-240	8.10E+05	8.82E+06	8.57E+05	1.14E+07
Pu-241	4.56E+07	3.58E+08	2.45E+08	4.37E+08
Am-241	1.62E+06	6.46E+06	8.88E+06	7.84E+06
Am-243	1.51E+06	1.11E+06	1.90E+06	1.16E+06
Cm-243	6.41E+06	1.71E+06	6.78E+08	1.79E+06
Cm-244	8.02E+06	1.57E+07	3.11E+08	2.04E+07

Table 6-37 Buried Pipe DCGLs for ROCs Adjusted for Insignificant Radionuclide Fractions

Radionuclide	Buried Pipe Group Insitu (dpm/100 cm^2)	Buried Pipe Group Excavation (dpm/100 cm^2)	Circulating Water Discharge Pipe Insitu (dpm/100 cm^2)	Circulating Water Discharge Pipe Excavation (dpm/100 cm^2)
Co-60	5.73E+06	7.60E+04	2.26E+08	7.76E+04
Sr-90	5.23E+05	3.63E+07	7.70E+05	3.86E+07
Cs-137	1.64E+07	3.24E+05	5.88E+08	3.30E+05
Eu-152	2.44E+08	1.64E+05	4.57E+14	1.67E+05
Eu-154	1.68E+08	1.53E+05	8.90E+17	1.56E+05

Table 6-38 Summed Buried Pipe DCGLs for ROCs adjusted for Insignificant Radionuclide Fractions

Radionuclide	Buried Pipe Group (dpm/100 cm^2)	Circulating Water Discharge Pipe (dpm/100 cm^2)
Co-60	7.50E+04	7.75E+04
Sr-90	5.16E+05	7.55E+05
Cs-137	3.18E+05	3.30E+05
Eu-152	1.64E+05	1.67E+05
Eu-154	1.52E+05	1.56E+05

6.21. Existing Groundwater Dose

There is low potential for significant groundwater contamination to be present although low concentrations have been identified in groundwater adjacent to suspected broken floor drains under the Turbine Building. Sampling in 1983 from a well located down gradient of the Turbine Building indicated positive groundwater contamination at relatively low concentrations.

In late 2012, five additional monitoring well pairs were installed to support site characterization and license termination. Results indicated lower groundwater contamination levels than found in 1983, predominantly H-3. See LTP Chapter 2 for a summary of characterization and HSA results prior to submittal of LACBWR LTP Revision 0. In December 2017, the analysis identified elevated H-3 with a maximum concentration of 24,200 pCi/L identified in February 2018 (well MW-203A). A subsequent sample from well MW-203A, collected in April 2018, contained lower H-3 concentrations of 12,100 pCi/L indicating a downward trend. An investigation is ongoing to identify the source of the contamination and the extent of contaminant migration. A report of the investigation results will be provided to NRC for evaluation. Groundwater Exposure Factors were calculated to determine the dose from existing groundwater contamination that may be present at the time of license termination.

Groundwater Exposure Factors for existing GW contamination were calculated for the five ROCs identified in Table 6-19 plus H-3. Because the industrial scenario does not include irrigation the only exposure pathway from groundwater is potable water from an onsite well. The GW Exposure Factors were therefore calculated in Reference (8) directly using the Federal Guidance Report 11 Ingestion Dose Conversion Factors and the assumed industrial worker AMCG drinking water intake rate of 327 L/yr. See Table 6-39.

Table 6-39 Groundwater Exposure Factors for a Water Concentration of 1 pCi/L

Radionuclide	Groundwater Exposure Factors (mrem/yr per pCi/L)
Co-60	8.80E-03
Cs-137	1.64E-02
Sr-90	4.64E-02
H-3	2.09E-05
Eu-152	2.12E-03
Eu-154	3.12E-03

6.22. Demonstrating Compliance with Dose Criterion

As discussed in section 6.5.6, the final demonstration of compliance with the dose criterion will be made through the summation of dose from each of the five media. The compliance dose will be calculated using Equation 6-11 after FSS has been completed in all survey units. Note that the acronym "BcDCGL" in Equation 6-11 is defined in Reference (4) as "Base Case DCGL" which is equivalent to the DCGLs developed in this Chapter. Different terminology was required in Reference (4) to distinguish the full DCGLs (which represent 25 mrem/yr) from the Operational DCGLs which represent a fraction of 25 mrem/yr (see Reference (4)). The acronym "SOF" in Equation 6-11 is defined as "Sum of Fractions".

The Release Record for each FSS unit will be reviewed to determine the maximum mean dose from each of the five source terms (e.g. basement, soil, buried pipe, above grade buildings, and existing GW). The compliance dose must be less than or equal to 25 mrem/yr. The calculation of the compliance dose will be documented in the final FSS Report for the site.

A detailed description of the terms in Equation 6-11 and the method for calculating the dose for each term is provided in Reference (4).

Equation 6-11

$$\text{Compliance Dose} = (\text{Max BcSOF}_{\text{BASEMENT}} + \text{Max BcSOF}_{\text{SOIL}} + \text{Max BcSOF}_{\text{BURIED PIPE}} + \text{BcSOF}_{\text{AG BUILDING}} + \text{GW BcSOF}_{\text{BS OB}} + \text{GW BcSOF}_{\text{BPS OBP}} + \text{Max SOF}_{\text{EGW}}) \times 25 \text{ mrem/yr}$$

where:

Compliance Dose	=	must be less than or equal to 25 mrem/yr,
Max $\text{BcSOF}_{\text{BASEMENT}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) for backfilled Basements,
Max $\text{BcSOF}_{\text{SOIL}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) for open land survey units,
Max $\text{BcSOF}_{\text{BURIED PIPE}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) from buried piping survey units,
Max $\text{BcSOF}_{\text{AG BUILDING}}$	=	Maximum BcSOF (mean of FSS systematic results plus the dose from any identified elevated areas) from above grade standing building survey units,
GW $\text{BcSOF}_{\text{BS OB}}$	=	Groundwater scenario dose from the "Other Basement" (OB) which is defined as the basement not used to generate the Max $\text{BcSOF}_{\text{BASEMENT}}$ term in Equation 1
GW $\text{BcSOF}_{\text{BPS OBP}}$	=	Groundwater scenario dose from the "Other Buried Pipe" (OBP) which is defined as the buried pipe survey unit not used to generate the Max $\text{BcSOF}_{\text{BURIED PIPE}}$ term in Equation 1
Max SOF_{EGW}	=	Maximum SOF from existing groundwater (EGW)

6.23. References

1. Haley & Aldrich Inc., Hydrogeological Investigation Report, La Crosse Boiling Water Reactor, Dairyland Power Cooperative, Genoa Wisconsin, File No. 38705-008, January 2015.
2. Energy*Solutions* Technical Support Document RS-TD-313196-003, Revision 0, La Crosse Boiling Water Reactor Historical Site Assessment (HSA).
3. U.S. Nuclear Regulatory Commission, NUREG-1757, Volume 2, Revision 1, Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, Final Report - September 2006.
4. Energy*Solutions* LC-FS-TSD-002, Revision 2, Operational Derived Concentration Guideline Levels for Final Status Survey.
5. Energy*Solutions* Technical Support Document RS-TD-313196-001, Revision 5, Radionuclides of Concern During LACBWR Decommissioning.
6. Pacific Northwest Laboratory, NUREG/CR-3474, Long-Lived Activation Products in Reactor Materials, Pacific Northwest Laboratory – 1984.
7. Pacific Northwest Laboratory, NUREG/CR-4289, Residual Radionuclide Concentration Within and Around Commercial Nuclear Power Plants; Origin, Distribution, Inventory, and Decommissioning Assessment – 1985.
8. Energy*Solutions* Technical Support Document RS-TD-313196-004, Revision 4, LACBWR Soil DCGL, Basement Concrete DCGL and Buried Pipe DCGL.
9. Argonne National Laboratory, NUREG/CR-6697, Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes – December 2000.
10. Sandia National Laboratory, NUREG/CR-5512, Volume 3, Residual Radioactive Contamination From Decommissioning Parameter Analysis – October 1999.
11. Zion*Solutions* Technical Support Document 14-006, Revision 5, Conestoga Rovers & Associates (CRA) Report, Evaluation of Hydrological Parameters in Support of Dose Modeling for the Zion Restoration Project.
12. Argonne National Laboratory, User's Manual for RESRAD Version 6, ANL/EAD-4, July 2001.
13. Sheppard and Thibault, Default Soil/Solid /Liquid Partition Coefficients, Kds, for Four Major Soil Types: A Compendium, Health Physics, Vol. 59 No 4, October 1990.
14. Energy*Solutions* Technical Support Document RS-TD-313196-002, Revision 0, Final LACBWR End State Basement Concrete Surface Areas, Volumes, and Void Spaces.

Figure 6-1 Site Regional Location

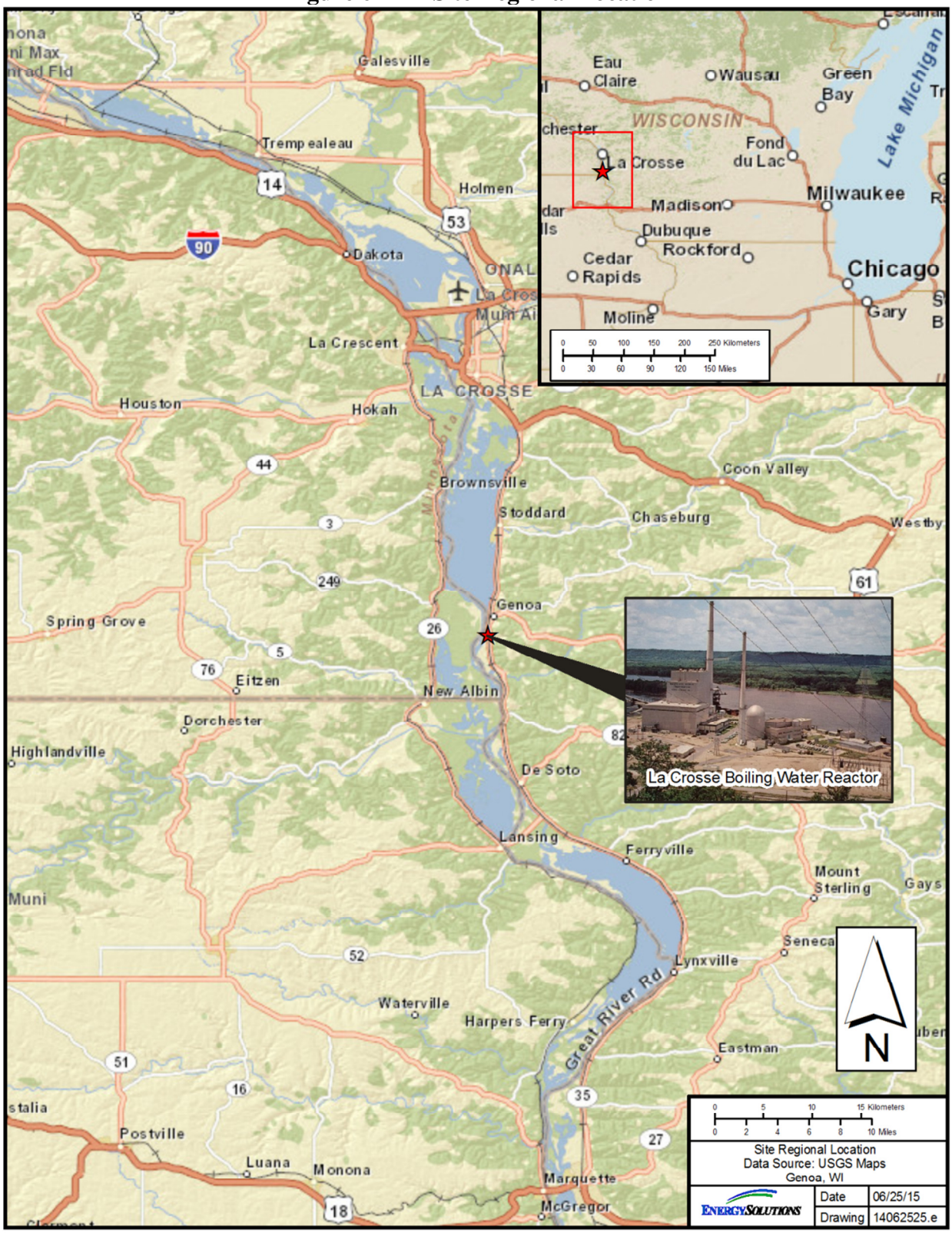


Figure 6-2 Site Overview

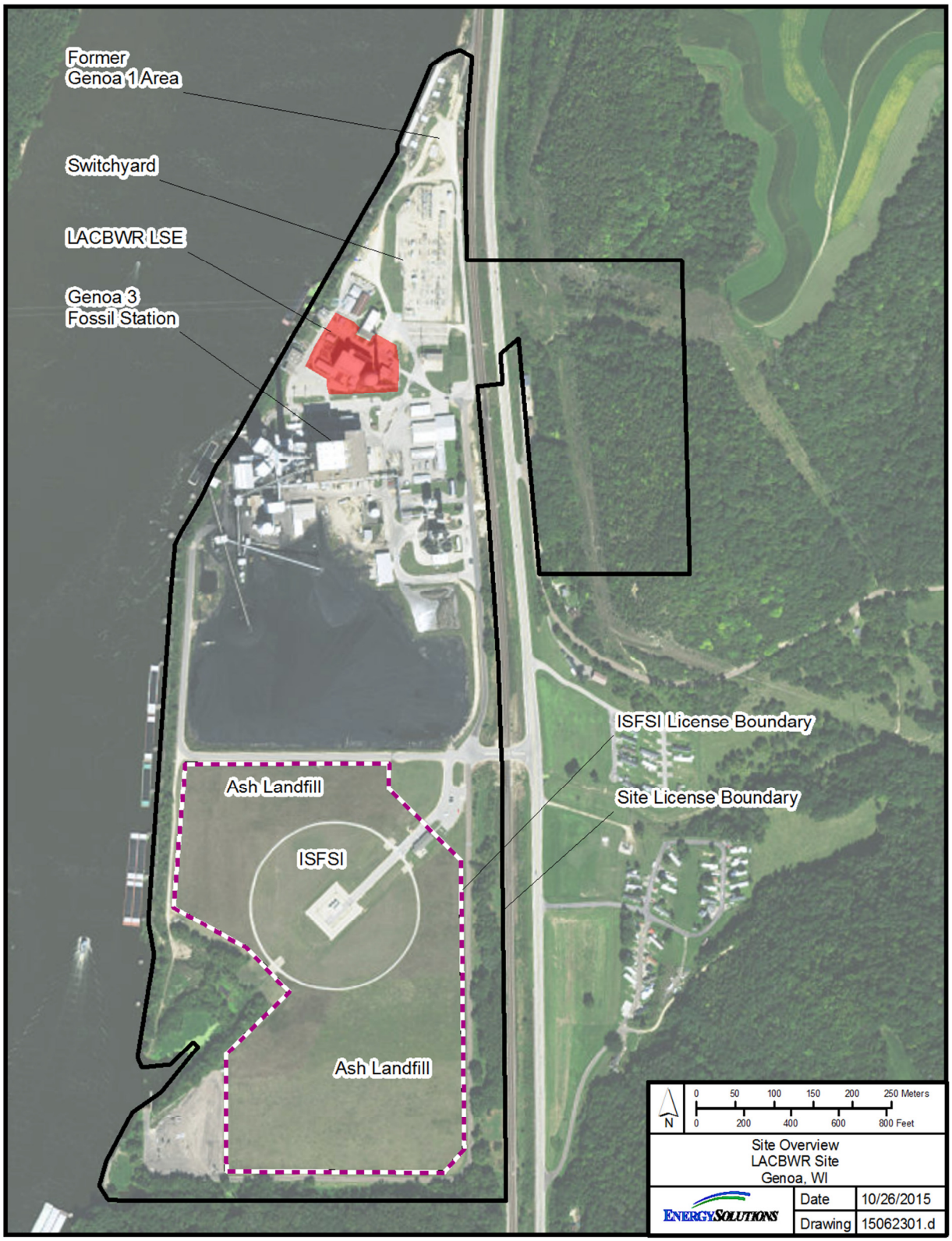


Figure 6-3 LACBWR Buildings

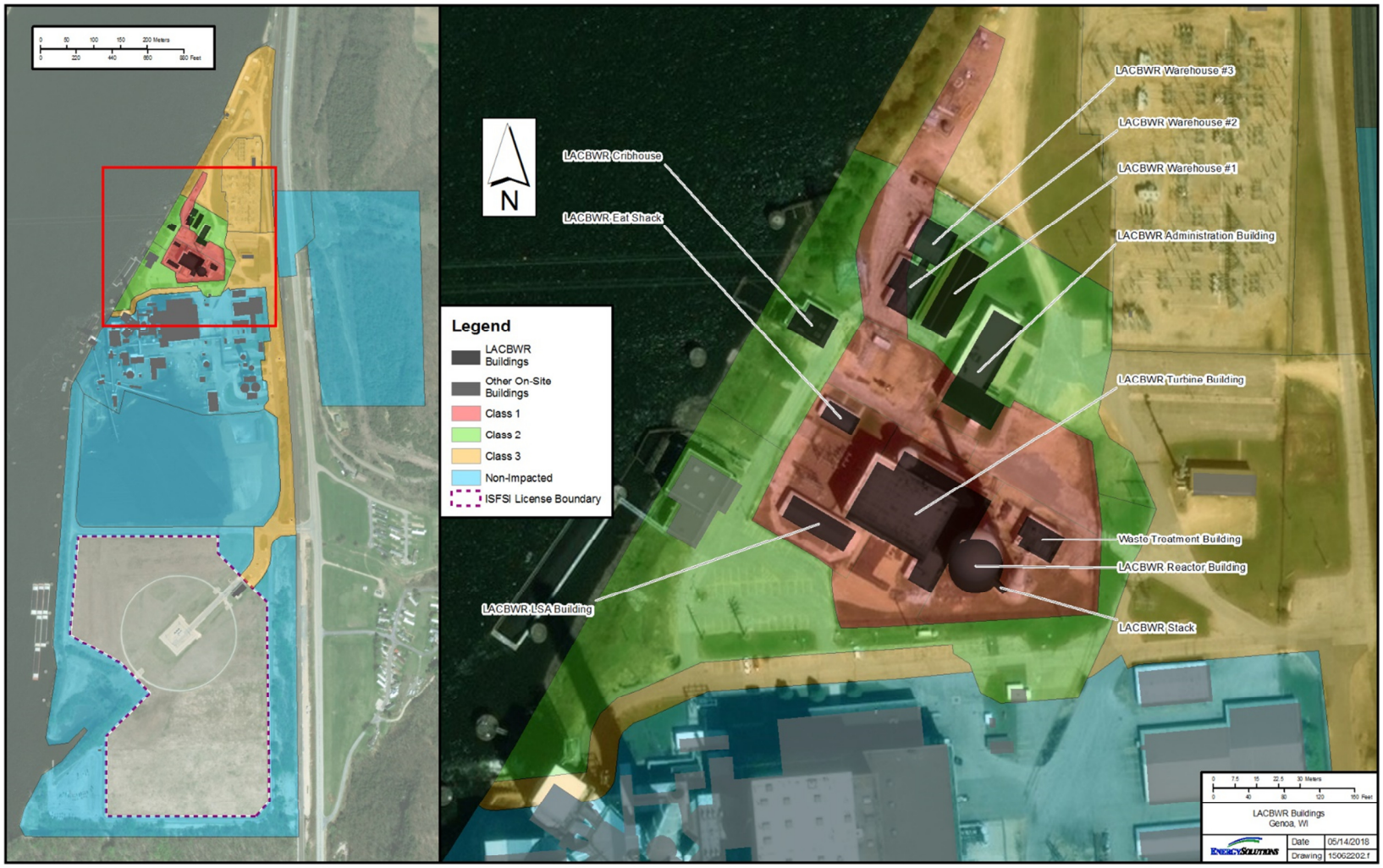


Figure 6-4 LACBWR End State

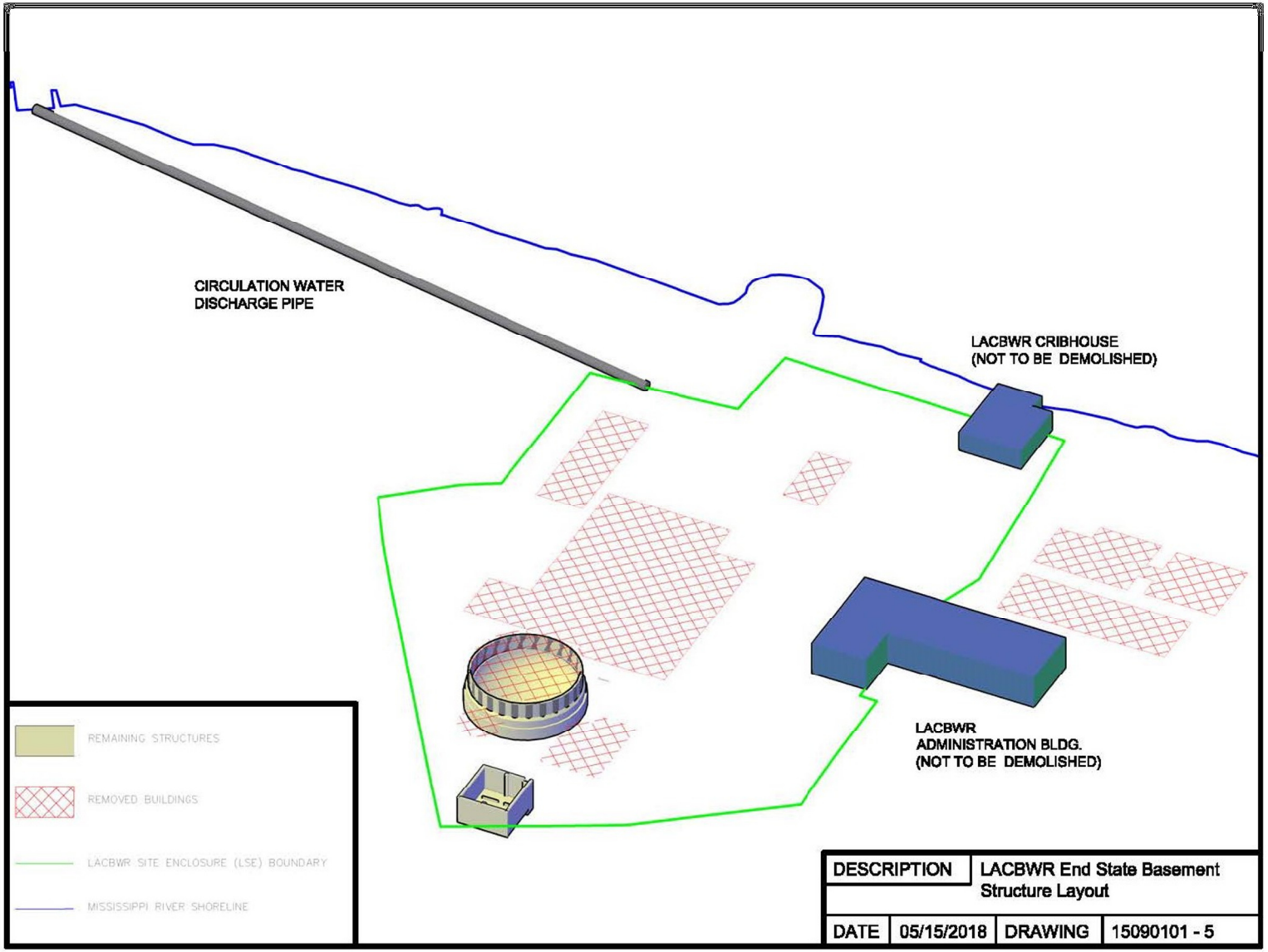


Figure 6-5 LACBWR End State - Backfilled Structures

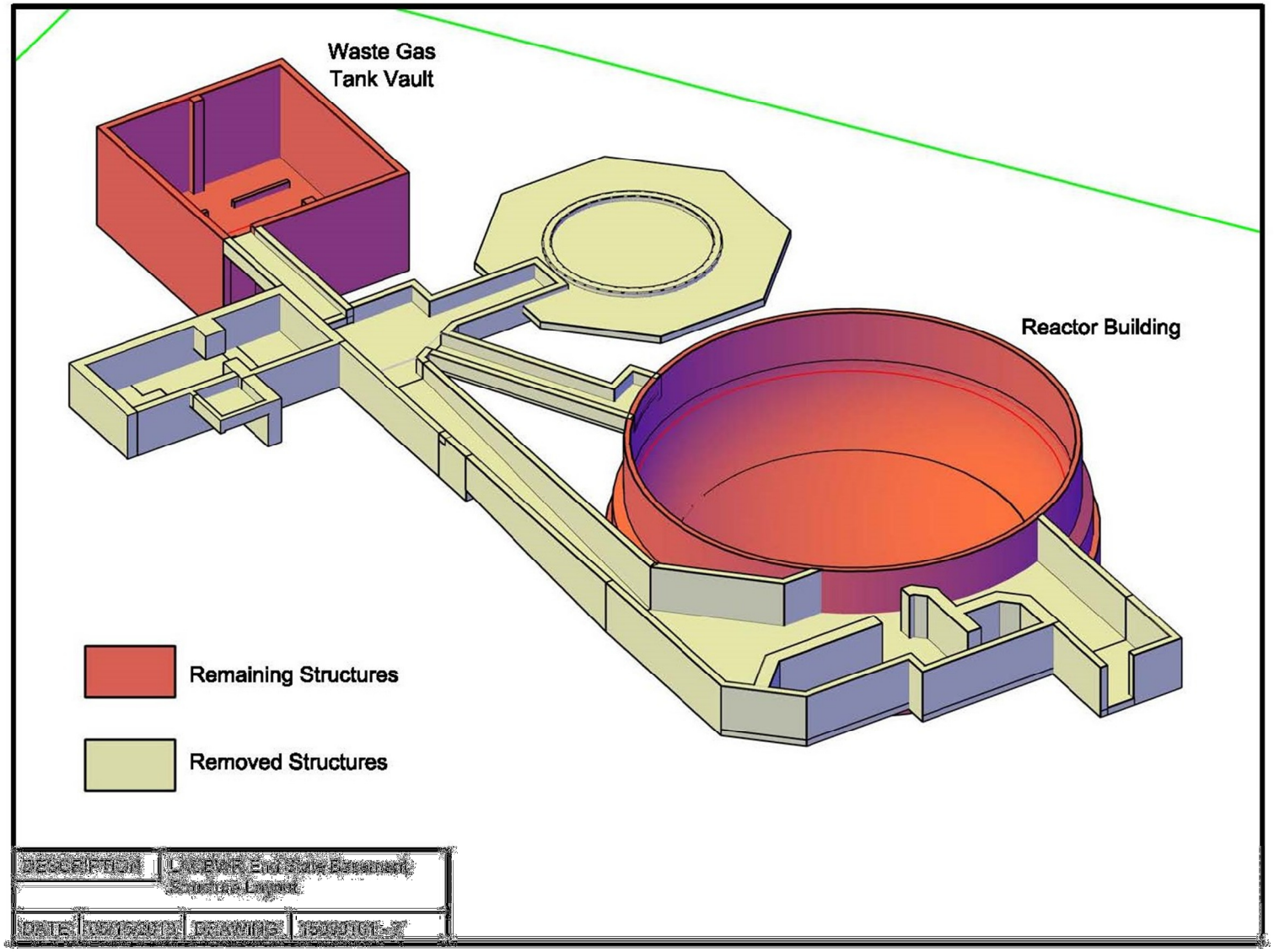


Figure 6-6 LACBWR End State – Backfilled Reactor Building Basement Elevation View

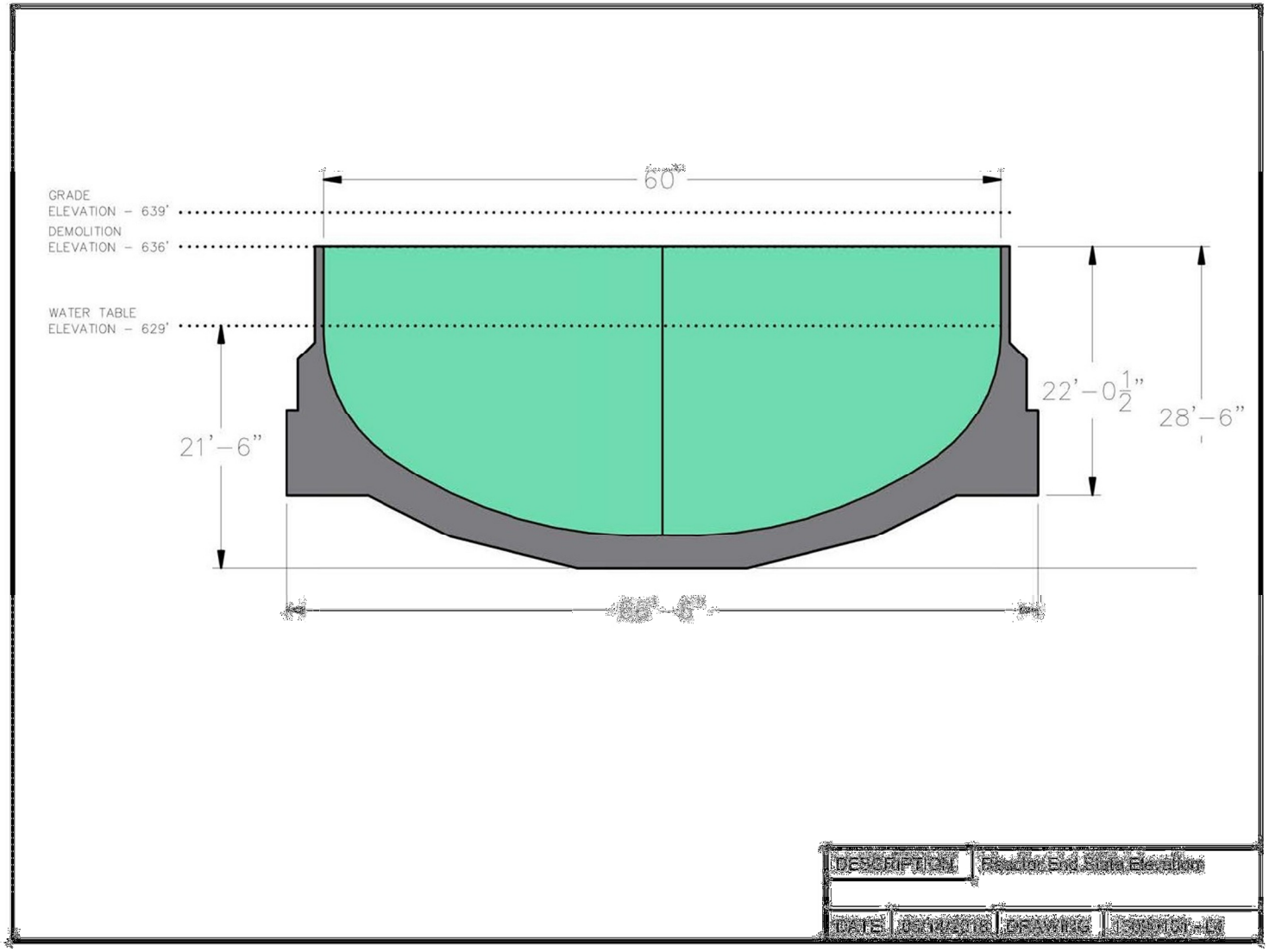
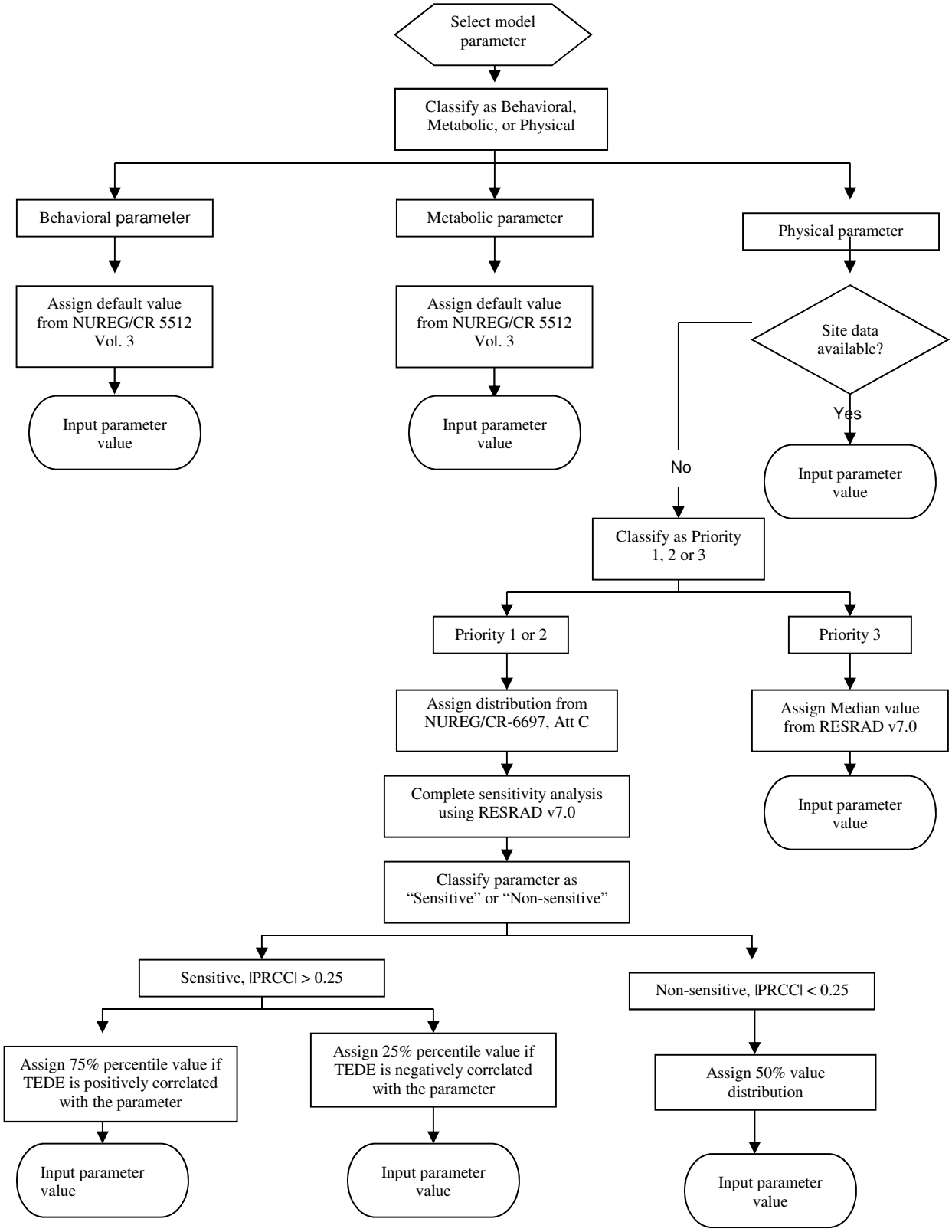


Figure 6-7 RESRAD Parameter Selection Flow Chart



ATTACHMENT 6-1

RESRAD Input Parameters for LACBWR Soil DCGL Uncertainty Analysis

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (contaminated, unsaturated, and saturated zones) (cm^3/g)										
Ac-227 (daughter of Cm-243 and Pu-239)	P	1	D	450	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	
Am-241 (also daughter of Cm-245 and Pu-241)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	7.28	3.15			1445
Am-243	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	7.28	3.15	NA	NA	1445
C-14	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	2.4	3.22	NA	NA	11
Cm-243	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	8.82	1.82	NA	NA	6761
Cm-244	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	8.82	1.82	NA	NA	6761
Co-60	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.46	2.53	NA	NA	235
Cs-137	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.1	2.33	NA	NA	446
Eu-152	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Eu-154	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Eu-155	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.94	3.22	NA	NA	380
Fe-155	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.34	2.67	NA	NA	209
Gd-152 (daughter for Eu-152)	P	1	D	825	Mean Value NUREG/CR-6697, Att. C (No sand value listed in Table 3.9-2)	NA	NA	NA	NA	NA
H-3	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	-2.81	0.5	NA	NA	0.06
Nb-94	P	1	S	Lognormal	NUREG/CR-6697 Att. C	5.94	3.22	NA	NA	380
Nd-144 (daughter for Eu-152)	P	1	D	158	RESRADv.7.0 Default Nd not listed in NUREG/CR-6697	NA	NA	NA	NA	NA
Ni-59	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.05	1.46	NA	NA	424
Ni-63	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.05	1.46	NA	NA	424

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Np-237 (also daughter for Am-241, Cm-245, and Pu-241)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	2.84	2.25	NA	NA	17
Pa-231 (daughter for Cm-243 and Pu-239)	P	1	D	550	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Pb-210 (daughter for Pu-238)	P	1	D	270	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Po-210 (daughter Pu-238)	P	1	D	150	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Pu-238	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Pu-239 (also daughter for Cm-243)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Pu-240 (also daughter for Cm-244)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Pu-241	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Ra-226 (daughter Pu-238)	P	1	D	500	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Ra-228 (daughter Cm-244 and Pu-240)	P	1	D	500	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Sm-148 (daughter Eu-152)	P	1	D	245	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	6.72	3.22	NA	NA	825
Sr-90	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	3.45	2.12	NA	NA	32
Tc-99	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	0.67	3.16	NA	NA	0.51
Th-228 (daughter Cm-244 and Pu-240)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Th-229 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA8.68	NA3.62	NA	NA	NA
Th-230 (daughter Cm-246 and Pu-238)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Th-232 (daughter Cm-244 and Pu-240)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
U-233 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault C	NA	NA	NA	NA	NA
U-234 (daughter Pu-238)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
U-235 (daughter Cm-243 and Pu-239)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
U-236 (daughter Cm-244 and Pu-240)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	NA	NA	NA	NA	NA
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	No existing groundwater contamination	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0	Start of dose calculation immediately after license termination	NR	NR	NR	NR	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	7500	Size of LACBWR "Licensed Site Exclusion" (LSE) area	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Thickness of contaminated zone (m)	P	2	D	1	Surface Soil contamination thickness not expected to exceed 1 m.	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	98	Diameter of 7500 m2 contaminated zone	NR	NR	NR	NR	
Does the initial contamination penetrate the water table?	NA	NA	NA	No	Contaminated zone at surface	NA	NA	NA	NA	
Contaminated fraction below water table	P	3	D	0	Contaminated zone at surface	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	No cover	NR	NR	NR	NR	
Density of cover material	P	2	D	NA	No cover	NR	NR	NR	NR	
Cover erosion rate	P,B	2	D	NA	No cover	NR	NR	NR	NR	
Density of contaminated zone (g/cm^3)	P	1	D	1.76	Site specific[e]	NR	NR	NR	NR	
Contaminated zone erosion rate m/y)	P,B	2	S	Continuous Logarithmic	NUREG/CR-6697 Att. C Table 3.8-1	5E-08	0.0007	0.005	0.2	0.0015
Contaminated zone total porosity	P	2	D	0.31	Site specific[e]	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.066	Calculated value for sand soil type[f]	NR	NR	NR	NR	
Contaminated zone hydraulic conductivity (m/y)	P	2	D	34822	Site specific[e] 313 feet/day = 34822 m/y	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Humidity in air (g/m^3)	P	3	D	7.2	Median NUREG/CR-6697 Att. C	1.98	0.334	0.001	0.999	7.2
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-6697 Att. C Figure 4.3-1	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	S	Bounded Lognormal - N	NUREG/CR-6697 Att. C Figure 4.5-1	1.445	0.2419	1.4	13	4.2
Precipitation (m/y)	P	2	D	0.78	NUREG/CR-6697 Att. C La Crosse, WI Table 4.1-2	NR	NR	NR	NR	
Irrigation (m/y)	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Irrigation mode	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Runoff coefficient	P	2	S	Uniform	NUREG/CR-6697 Att. C Figure 4.2-1	0.1	0.8	NR	NR	0.45
Watershed area for nearby stream or pond (m^2)	P	3	D	1.00E+06	RESRAD Default	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	2	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.31	Site-specific[e]	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.28	Site-specific[e]	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.066	Calculated values for sand soil type[f]	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	34822	Site-specific value[e] 313 feet/day = 34822 m/y	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	D	0.0045	Site-specific[e]	NR	NR	NR	NR	
Saturated zone b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Water table drop rate (m/y)	P	3	D	0	Assumed zero due to hydraulic connectivity with Mississippi river.	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Well pump intake depth (m below water table)	P	2	S	Triangular	Site-specific distribution Existing industrial water supply wells onsite at depth of 116' and 129' below ground surface (the 129' depth equals 36.3 m below the water table). 36.3 m assumed to be maximum well depth. Minimum well depth assumed to be represented by a nominal 20' screen depth (6.1 m) starting at the maximum "seasonal" water table elevation of 629' and extending to 10' below 619' elevation where water table continuously present. Mode is assumed to be mid-point between 6.1 m and 36.3 m which is 21.2 m. Note that the site-specific distribution is reasonably similar to the NUREG-6697 distribution values of 6, 10, and 30 for the triangular distribution.	618	21.2	36.3	NR	21.2
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	Applicable to flowing groundwater	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Well pumping rate (m^3/y)	P	2	S	Uniform	NUREG/CR-6697, Att. C provides no recommended value due to high variability. Industrial Scenario pump rate depends on industry. NUREG-6697, Table 3.10-1 applies a sanitary and potable water usage rate for four persons of 328.7 m^3/yr. This value is assumed to be the minimum industrial rate. Maximum industrial rate assumed to supply 20 workers which equates to1643.5 m^3/yr.	328.7	1643.5	NR	NR	986.1
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone thickness (m)	P	1	D	2.05 m	Site Specific[e] Calculated assuming ground surface 639' elevation, Contaminated Zone Thickness 1 m, and maximum water table elevation of 629'.	NR	NR	NR	NR	
Unsat. zone soil density (g/cm^3)	P	2	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone total porosity	P	2	D	0.31	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone effective porosity	P	2	D	0.28	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone field capacity	P	3	D	0.066	Calculated values for sand soil type[f]	NR	NR	NR	NR	
Unsat. zone hydraulic conductivity (m/y)	P	2	D	34822	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone soil-specific b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Occupancy										

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Inhalation rate (m^3/y)	M,B	3	D	3066	NUREG-6697 Att. C, Table 7.6-1 recommends a median indoor work day as 8.76 hours/day. Assuming 5 days a week and 50 weeks per years this equates to 2190 hours per year. NUREG/CR-5512, Vol. 3, Section 5.3.4 recommends an inhalation rate for workers in light industry of 1.4 m^3/hr. Industrial Scenario m^3/yr = 1.4 m^3/hr * 2190 hr/yr = 3066 m^3/yr.	NR	NR	NR	NR	
Mass loading for inhalation (g/m^3)	P,B	2	S	Continuous Linear	NUREG/CR-6697, Att. C	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	2.35E-05
Exposure duration	B	3	D	30	RESRAD User's Manual parameter value not used in dose calculation	NR	NR	NR	NR	
Indoor dust filtration factor	P,B	2	S	Uniform	NUREG/CR-6697, Att. C Figure 7.1-1	0.15	0.95	NR	NR	0.55
Shielding factor, external gamma	P	2	S	Bounded Lognormal-N	NUREG/CR-6697, Att. C Table 7.10-1	-1.3	0.59	0.044	1	0.2725

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Fraction of time spent indoors	B	3	D	0.1875	NUREG-6697 Att. C, Table 7.6-1 recommends a median indoor work day as 8.76 hours/day. Assuming 5 days a week and 50 weeks per years this equates to 2190 hours per year. Majority of industrial work is expected to be indoors. Consistent with Table 2-3 of the "User's Manual for RESRAD Version 6"[9] 75% of work time is indoors and 25% outdoors. The corresponding RESRAD indoor Fraction parameter = (2190*.75)/(24*365) = .1875	NR	NR	NR	NR	
Fraction of time spent outdoors (on site)	B	3	D	0.0625	As explained in the basis for the Indoor Fraction parameter, the indoor time fraction was set at 75% and outdoor time fraction at 25%. (2190*.25)/(24*365) = 0.0625	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	Circular contaminated zone assumed for modeling purposes	NR	NR	NR	NR	
Ingestion, Dietary										
Fruits, non-leafy vegetables, grain consumption (kg/y)	M,B	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Milk consumption (L/y)	M,B	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fish consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Other seafood consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Soil ingestion rate (g/y)	M,B	2	D	18.3	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Drinking water intake (L/y)	M,B	2	D	327	NUREG/CR-5512, Vol. 3 Table 6.87 Industrial Scenario water supply assumed to be from an onsite well. 478 L/y from NUREG/CR-5512 corresponds to 1.31 L/d which is considered a conservative value for 8 hour work day. 1.31 L/d * 250 work days = 327 L/y	NR	NR	NR	NR	
Contamination fraction of drinking water	B,P	3	D	1	All water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water (if used)	B,P	3		1	All water from well					
Contamination fraction of livestock water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of irrigation water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of aquatic food	B,P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of plant food	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of meat	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of milk	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock water intake for meat (L/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Livestock water intake for milk (L/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock soil intake (kg/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	S	Triangular	NUREG/CR-6697, Att. C Figure 3.12-1	0	0.15	0.6	NR	0.15
Depth of roots (m)	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Drinking water fraction from ground water	B,P	3	D	1	Industrial Scenario	NR	NR	NR	NR	
Household water fraction from ground water (if used)	B,P	3		1	Industrial Scenario	NR	NR	NR	NR	
Livestock water fraction from ground water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Irrigation fraction from ground water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Weathering Removal Constant for Vegetation (1/y)	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Fodder	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Leafy vegetables	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Milk	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Meat and poultry	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fish	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Well water	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Surface water	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock fodder	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14 evasion flux rate from soil (1/sec)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/sec)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of grain in beef cattle feed	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dose Conversion Factors (Inhalation mrem/pCi)										

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Ac-227	M	3	D	6.70E+00	FGR11	NR	NR	NR	NR	
Am-241	M	3	D	4.44E-01	FGR11	NR	NR	NR	NR	
Am-243	M	3	D	4.40E-01	FGR11	NR	NR	NR	NR	
C-14	M	3	D	2.09E-06	FGR11	NR	NR	NR	NR	
Cm-243	M	3	D	3.07E-01	FGR11	NR	NR	NR	NR	
Cm-244	M	3	D	2.48E-01	FGR11	NR	NR	NR	NR	
Cm-245	M	3	D	4.55E-01	FGR11	NR	NR	NR	NR	
Cm-246	M	3	D	4.51E-01	FGR11	NR	NR	NR	NR	
Co-60	M	3	D	2.19E-04	FGR11	NR	NR	NR	NR	
Cs-134	M	3	D	4.62E-05	FGR11	NR	NR	NR	NR	
Cs-137	M	3	D	3.19E-05	FGR11	NR	NR	NR	NR	
Eu-152	M	3	D	2.21E-04	FGR11	NR	NR	NR	NR	
Eu-154	M	3	D	2.86E-04	FGR11	NR	NR	NR	NR	
Gd-152	M	3	D	2.43E-01	FGR11	NR	NR	NR	NR	
H-3	M	3	D	6.40E-08	FGR11	NR	NR	NR	NR	
I-129	M	3	D	1.74E-04	FGR11	NR	NR	NR	NR	
Nb-94	M	3	D	4.14E-04	FGR11	NR	NR	NR	NR	
Nd-144[e]	M	3	D	7.04E-02	ICRP60	NR	NR	NR	NR	
Ni-59	M	3	D	2.70E-06	FGR11	NR	NR	NR	NR	
Ni-63	M	3	D	6.29E-06	FGR11	NR	NR	NR	NR	
Np-237	M	3	D	5.40E-01	FGR11	NR	NR	NR	NR	
Pa-231	M	3	D	1.28E+00	FGR11	NR	NR	NR	NR	
Pb-210	M	3	D	1.36E-02	FGR11	NR	NR	NR	NR	
Po-210	M	3	D	9.40E-03	FGR11	NR	NR	NR	NR	
Pu-238	M	3	D	3.92E-01	FGR11	NR	NR	NR	NR	
Pu-239	M	3	D	4.29E-01	FGR11	NR	NR	NR	NR	
Pu-240	M	3	D	4.29E-01	FGR11	NR	NR	NR	NR	
Pu-241	M	3	D	8.25E-03	FGR11	NR	NR	NR	NR	
Pu-242	M	3	D	4.11E-01	FGR11	NR	NR	NR	NR	
Ra-226	M	3	D	8.58E-03	FGR11	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Ra-228	M	3	D	4.77E-03	FGR11	NR	NR	NR	NR	
Sm-148[e]	M	3	D	7.34E-02	ICRP60	NR	NR	NR	NR	
Sr-90	M	3	D	1.30E-03	FGR11	NR	NR	NR	NR	
Tc-99	M	3	D	8.32E-06	FGR11	NR	NR	NR	NR	
Th-228	M	3	D	3.42E-01	FGR11	NR	NR	NR	NR	
Th-229	M	3	D	2.15E+00	FGR11	NR	NR	NR	NR	
Th-230	M	3	D	3.26E-01	FGR11	NR	NR	NR	NR	
Th232	M	3	D	1.64e+00	FGR11	NR	NR	NR	NR	
U-233	M	3	D	1.35E-01	FGR11	NR	NR	NR	NR	
U-234	M	3	D	1.32E-01	FGR11	NR	NR	NR	NR	
U-235	M	3	D	1.23E-01	FGR11	NR	NR	NR	NR	
U-236	M	3	D	1.25E-01	FGR11	NR	NR	NR	NR	
U-238	M	3	D	1.18E-01	FGR11	NR	NR	NR	NR	
Dose Conversion Factors (Ingestion mrem/pCi)										
Ac-227	M	3	D	1.41E-02	FGR11	NR	NR	NR	NR	
Am-241	M	3	D	3.64E-03	FGR11	NR	NR	NR	NR	
Am-243	M	3	D	3.62E-03	FGR11	NR	NR	NR	NR	
C-14	M	3	D	2.09E-06	FGR11	NR	NR	NR	NR	
Cm-243	M	3	D	2.51E-03	FGR11	NR	NR	NR	NR	
Cm-244	M	3	D	2.02E-03	FGR11	NR	NR	NR	NR	
Cm-245	M	3	D	3.74E-03	FGR11	NR	NR	NR	NR	
Cm-246	M	3	D	3.70E-03	FGR11	NR	NR	NR	NR	
Co-60	M	3	D	2.69E-05	FGR11	NR	NR	NR	NR	
Cs-134	M	3	D	7.33E-05	FGR11	NR	NR	NR	NR	
Cs-137	M	3	D	5.00E-05	FGR11	NR	NR	NR	NR	
Eu-152	M	3	D	6.48E-06	FGR11	NR	NR	NR	NR	
Eu-154	M	3	D	9.55E-06	FGR11	NR	NR	NR	NR	
Gd-152	M	3	D	1.61E-04	FGR11	NR	NR	NR	NR	
H-3	M	3	D	6.40E-08	FGR11	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
I-129	M	3	D	2.76E-04	FGR11	NR	NR	NR	NR	
Nb-94	M	3	D	7.14E-06	FGR11	NR	NR	NR	NR	
Nd-144[e]	M	3	D	1.51E-04	ICRP60	NR	NR	NR	NR	
Ni-59	M	3	D	2.10E-07	FGR11	NR	NR	NR	NR	
Ni-63	M	3	D	5.77E-07	FGR11	NR	NR	NR	NR	
Np-237	M	3	D	4.44E-03	FGR11	NR	NR	NR	NR	
Pa-231	M	3	D	1.06E-02	FGR11	NR	NR	NR	NR	
Pb-210	M	3	D	5.37E-03	FGR11	NR	NR	NR	NR	
Po-210	M	3	D	1.90E-03	FGR11	NR	NR	NR	NR	
Pu-238	M	3	D	3.20E-03	FGR11	NR	NR	NR	NR	
Pu-239	M	3	D	3.54E-03	FGR11	NR	NR	NR	NR	
Pu-240	M	3	D	3.54E-03	FGR11	NR	NR	NR	NR	
Pu-241	M	3	D	6.84E-05	FGR11	NR	NR	NR	NR	
Pu-242	M	3	D	3.36E-03	FGR11	NR	NR	NR	NR	
Ra-226	M	3	D	1.32E-03	FGR11	NR	NR	NR	NR	
Ra-228	M	3	D	1.44E-03	FGR11	NR	NR	NR	NR	
Sm-148[e]	M	3	D	1.58E-04	ICRP60	NR	NR	NR	NR	
Sr-90	M	3	D	1.42E-04	FGR11	NR	NR	NR	NR	
Tc-99	M	3	D	1.46E-06	FGR11	NR	NR	NR	NR	
Th-228	M	3	D	3.96E-04	FGR11	NR	NR	NR	NR	
Th-229	M	3	D	3.53E-03	FGR11	NR	NR	NR	NR	
Th-230	M	3	D	5.48E-04	FGR11	NR	NR	NR	NR	
Th-232	M	3	D	2.73E-03	FGR11	NR	NR	NR	NR	
U-233	M	3	D	2.89E-04	FGR11	NR	NR	NR	NR	
U-234	M	3	D	2.83E-04	FGR11	NR	NR	NR	NR	
U-235	M	3	D	2.66E-04	FGR11	NR	NR	NR	NR	
U-236	M	3	D	2.69E-04	FGR11	NR	NR	NR	NR	
U-238	M	3	D	2.55E-04	FGR11	NR	NR	NR	NR	
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Am-241	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-134	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fe-55	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nd-144	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pm-147	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sb-125	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sm-148	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Sr-90	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Tc-99	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ag-108m	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-134	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fe-55	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nd-144	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Np-237	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sb-125	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sm-148	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Tc-99	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Cs-134	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fe-55	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nd-144	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sm-148	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Tc-99	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
U-235	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-245	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-246	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
I-129	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Pu-242	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L))										
Ac-227	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-245	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-246	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
I-129	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

SOIL DCGL: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Nb-94	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	S	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-242	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-238	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Notes:

a P = physical, B = behavioral, M = metabolic; (see NUREG/CR-6697, Attachment B, Table 4.)
b 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter (see NUREG/CR-6697, Attachment B, Table 4.1)
c D = deterministic, S = stochastic
d Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Beta: 1 = minimum, 2 = maximum, 3 = P-value, 4 = Q-value
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum e Sm-148 an ND-144 not listed in RESRAD FGR 11 DCF file
e Reference: Haley and Aldrich, Inc., "Hydrogeological Investigation Report La Crosse Boiling Water Reactor, Dairyland Power Cooperative, Genoa, WI" January 2015
f ZionSolutions Technical Support Document 14-003, Conestoga Rovers & Associates (CRA) Report, "Zion Hydrogeologic Investigation Report"
g Argonne National Laboratory, "User's Manual for RESRAD Version 6", ANL/EAD 4, July 2001

ATTACHMENT 6-2

RESRAD Input Parameters for LACBWR BFM Uncertainty Analysis

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	1	Unit Value	NR	NR	NR	NR	
Distribution coefficients (contaminated, unsaturated, and saturated zones) (cm^3/g)										
Ac-227 (daughter of Cm-243 and Pu-239)	P	1	D	450	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	6.72	3.22	NA	NA	825
Am-241 (also daughter of Cm-245 and Pu-241)	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Am-243	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
C-14	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	2.4	3.22	NA	NA	11
Cm-243	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Cm-244	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Co-60	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.46	2.53	NA	NA	235
Cs-137	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.1	2.33	NA	NA	446
Eu-152	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Eu-154	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Eu-155	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Fe-55	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.34	2.67	NA	NA	209
Gd-152 (daughter for Eu-152)	P	1	D	825	Median Value NUREG/CR-6697, Att. C (No sand value listed in Table 3.9-2)	6.72	3.22	NA	NA	825
H-3	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	-2.81	0.5	NA	NA	0.06
Nb-94	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Nd-144 (daughter for Eu-152)	P	1	D	158	RESRADv.7.0 Default Nd not listed in NUREG/CR-6697	NA	NA	NA	NA	NA
Ni-59	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.05	1.46	NA	NA	424
Ni-63	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.05	1.46	NA	NA	424

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Np-237 (also daughter for Am-241, Cm-245, and Pu-241)	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Pa-231 (daughter for Cm-243 and Pu-239)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Pb-210 (daughter for Pu-238)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Po-210 (daughter Pu-238)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Pu-238	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Pu-239 (also daughter for Cm-243)	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Pu-240 (also daughter for Cm-244)	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Pu-241	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Ra-226 (daughter Pu-238)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Ra-228 (daughter Cm-244 and Pu-240)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Sm-148 (daughter Eu-152)	P	1	D	245	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	6.72	3.22	NA	NA	825
Sr-90	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	3.45	2.12	NA	NA	32
Tc-99	P	1	S	Not Included in Uncertainty Analysis	< 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Th-228 (daughter Cm-244 and Pu-240)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Th-229 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.68	3.62	NA	NA	5884
Th-230 (daughter Cm-246 and Pu-238)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Th-232 (daughter Cm-244 and Pu-240)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
U-233 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault C	4.84	3.13	NA	NA	126

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
U-234 (daughter Pu-238)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
U-235 (daughter Cm-243 and Pu-239)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
U-236 (daughter Cm-244 and Pu-240)	P	1	D	Not Included in Uncertainty Analysis	parent < 0.1% of radionuclide mixture	NA	NA	NA	NA	NA
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	No existing groundwater contamination	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0	Start of dose calculation immediately after license termination	NR	NR	NR	NR	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	Variable	Source term and physical geometries vary for the five structures evaluated for BFM Insitu$_{gw}$ Uncertainty Analyses (see Table 6-8 in text)	NR	NR	NR	NR	
Thickness of contaminated zone (m)	P	2	D	Variable	Source term and physical geometries vary for the five structures evaluated for BFM Insitu$_{gw}$ Uncertainty Analyses (see Table 6-8 in text)	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	Variable	Source term and physical geometries vary for the five structures evaluated for BFM Insitu$_{gw}$ Uncertainty Analyses (see Table 6-8 in text)	NR	NR	NR	NR	
Contaminated fraction below water table	P	3	D	Variable	Source term and physical geometries vary for the five structures evaluated for BFM Insitu$_{gw}$ Uncertainty Analyses (see Table 6-8 in text)	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	Variable	Source term and physical geometries vary for the five structures evaluated for BFM Insitu$_{gw}$ Uncertainty Analyses (see Table 6-8 in text)	NR	NR	NR	NR	
Density of cover material	P	2	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Cover erosion rate	P,B	2	S	Continuous Logarithmic	NUREG/CR-6697 Att. C Table 3.8-1	5E-08	0.0007	0.005	0.2	0.0015
Density of contaminated zone (g/cm^3)	P	1	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Contaminated zone erosion rate m/y)	P,B	2	S	Continuous Logarithmic	NUREG/CR-6697 Att. C Table 3.8-1	5E-08	0.0007	0.005	0.2	0.0015
Contaminated zone total porosity	P	2	D	0.31	Site-specific[e]	NR	NR	NR	NR	0.43
Contaminated zone field capacity	P	3	D	0.2	RESRAD default. No distribution or median value provided in NURE/CR-6697 Att. C	NR	NR	NR	NR	
Contaminated zone hydraulic conductivity (m/y)	P	2	D	34822	Site-specific[e] 313 feet/day = 34822 m/y	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Humidity in air (g/m^3)	P	3	D	7.2	Median NUREG/CR-6697 Att. C	1.98	0.334	0.001	0.999	7.2
Evapotranspiration coefficient	P	2	S	0	Site-specific value to force the Precipitation parameter to equal to the infiltration rate (see text section 6.11.1.2)	NR	NR	NR	NR	NR
Average annual wind speed (m/s)	P	2	S	Bounded Lognormal - N	NUREG/CR-6697 Att. C Figure 4.5-1	1.445	0.2419	1.4	13	4.2

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Precipitation (m/y)	P	2	S	Uniform	For the BFM analysis the Evapotranspiration coefficient and Runoff coefficient were set to zero to force the Precipitation parameter to equal the infiltration rate. This was necessary to incorporate the effect of seasonal ground water elevation rise associated with the Mississippi river stage. Minimum value of 0.25 is traditional infiltration rate based on Evapotranspiration coefficient, Runoff coefficient and site precipitation rate parameters listed in the parameter set for Soil DCGL. The maximum value of 3.05 is the seasonal high groundwater elevation at the site as driven by river stage.	0.25	3.05	NR	NR	
Irrigation (m/y)	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Irrigation mode	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Runoff coefficient	P	2	D	0	Site-specific value to force the Precipitation parameter to equal to the infiltration rate. See section 6.11.1.2.	NR	NR	NR	NR	NR
Watershed area for nearby stream or pond (m^2)	P	3	D	1.00E+06	RESRAD Default	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	2	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.31	Site-specific[e]	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.28	Site-specific[e]	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.066	Calculated values for sand soil type[f]	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	34822	Site-specific[e] 313 feet/day = 34822 m/y	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	D	0.0045	Site-specific value[e]	NR	NR	NR	NR	
Saturated zone b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Water table drop rate (m/y)	P	3	D	0	Assumed zero due to hydraulic connectivity with Mississippi river.	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Well pump intake depth (m below water table)	P	2	S	Triangular	Site-specific distribution Existing industrial water supply wells onsite at depth of 116' and 129' below ground surface (the 129' depth equals 33.1 m below the water table). 33.1 m assumed to be maximum well depth. Minimum well depth assumed to be represented by nominal 20' screen depth (6.08 m) from top of water table. Mode is mid-point between 6.08m and 33.1 m which is 19.6 m. Note that the site-specific distribution is reasonably similar to the NUREG-6697 distribution values of 6, 10, and 30 for the triangular distribution.	6.08	19.6	33.1	NR	10
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	Applicable to moving groundwater	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Well pumping rate (m^3/y)	P	2	S	Uniform	NUREG/CR-6697, Att. C provides no recommended value due to high variability. Industrial Scenario pump rate depends on industry. General water usage rate for four persons is 328.7 m^3/yr (NUREG-6697, Table 3.10-1) which is assumed to be minimum industrial rate. Maximum industrial rate assumed to supply 20 workers which equals 1643.5 m^3/yr.	328.7	1643.5	NR	NR	986.1
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	Site-specific	NR	NR	NR	NR	
Unsat. zone thickness (m)	P	1	D	Variable	Structure specific	NR	NR	NR	NR	
Unsat. zone soil density (g/cm^3)	P	2	D	1.76	Site specific [e]	NR	NR	NR	NR	
Unsat. zone total porosity	P	2	D	0.31	Site specific [e]	NR	NR	NR	NR	
Unsat. zone effective porosity	P	2	D	0.28	Site specific [e]	NR	NR	NR	NR	
Unsat. zone field capacity	P	3	D	0.066	Calculated values for sand soil type[f]	NR	NR	NR	NR	
Unsat. zone hydraulic conductivity (m/y)	P	2	D	34822	Site-specific value[e]	NR	NR	NR	NR	
Unsat. zone soil-specific b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Occupancy										
Inhalation rate (m^3/y)	M,B	3	D	1917	NUREG/CR-5512, Vol. 3 Table 5.1.1 mean value is 8400/y which equates to 23 m^3/d Industrial Scenario m^3/yr =23 m^3/d ÷ 24h/d * 2000 h/y)	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Mass loading for inhalation (g/m^3)	P,B	2	S	Continuous Linear	NUREG/CR-6697, Att. C	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	2.35E-05
Exposure duration	B	3	D	30	RESRAD User's Manual parameter value not used in dose calculation	NR	NR	NR	NR	
Indoor dust filtration factor	P,B	2	S	Uniform	NUREG/CR-6697, Att. C Figure 7.1-1	0.15	0.95	NR	NR	0.55
Shielding factor, external gamma	P	2	S	Bounded Lognormal-N	NUREG/CR-6697, Att. C Table 7.10-1	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.1875	NUREG-6697 Att. C, Table 7.6-1 recommends a median indoor work day as 8.76 hours/day. Assuming 5 days a week and 50 weeks per years this equates to 2190 hours per year. Majority of industrial work is expected to be indoors. Consistent with Table 2-3 of the "User's Manual for RESRAD Version 6"[g] 75% of work time is indoors and 25% outdoors. The corresponding RESRAD indoor Fraction parameter = (2190*.75)/(24*365) = .1875	NR	NR	NR	NR	
Fraction of time spent outdoors (on site)	B	3	D	0.0625	As explained in the basis for the Indoor Fraction parameter, the indoor time fraction was set at 75% and outdoor time fraction at 25%. (2190*.25)/(24*365) = 0.0625	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	Circular contaminated zone assumed for modeling purposes	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Ingestion, Dietary										
Fruits, non-leafy vegetables, grain consumption (kg/y)	M,B	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Milk consumption (L/y)	M,B	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fish consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Other seafood consumption (kg/y)	M,B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Soil ingestion rate (g/y)	M,B	2	D	18.3	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Drinking water intake (L/y)	M,B	2	D	327	NUREG/CR-5512, Vol. 3 Table 6.87 Industrial Scenario water supply assumed to be from an onsite well. 478 L/y from NUREG/CR-5512 corresponds to 1.31 L/d which is considered a conservative value for 8 hour work day. 1.31 L/d * 250 work days = 327 L/y	NR	NR	NR	NR	
Contamination fraction of drinking water	B,P	3	D	1	All water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of household water (if used)	B,P	3		1	All water from well					
Contamination fraction of livestock water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of irrigation water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of aquatic food	B,P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of plant food	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Contamination fraction of meat	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Contamination fraction of milk	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock water intake for meat (L/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock water intake for milk (L/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock soil intake (kg/day)	M	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	D	Triangular	NUREG/CR-6697, Att. C Figure 3.12-1	0	0.15	0.6	NR	0.15
Depth of roots (m)	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Drinking water fraction from ground water	B,P	3	D	1	Industrial Scenario	NR	NR	NR	NR	
Household water fraction from ground water (if used)	B,P	3		1	Industrial Scenario	NR	NR	NR	NR	
Livestock water fraction from ground water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Irrigation fraction from ground water	B,P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet weight crop yield for Leafy (kg/m^2)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Weathering Removal Constant for Vegetation (1/y)	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Fodder	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Leafy vegetables	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Milk	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Meat and poultry	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fish	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Well water	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Surface water	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Livestock fodder	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14 evasion flux rate from soil (1/sec)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/sec)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Fraction of grain in beef cattle feed	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Dose Conversion Factors (Inhalation mrem/pCi)										
Ac-227	M	3	D	6.70E+00	FGR11	NR	NR	NR	NR	
Am-241	M	3	D	4.44E-01	FGR11	NR	NR	NR	NR	
Am-243	M	3	D	4.40E-01	FGR11	NR	NR	NR	NR	
C-14	M	3	D	2.09E-06	FGR11	NR	NR	NR	NR	
Cm-243	M	3	D	3.07E-01	FGR11	NR	NR	NR	NR	
Cm-244	M	3	D	2.48E-01	FGR11	NR	NR	NR	NR	
Cm-245	M	3	D	4.55E-01	FGR11	NR	NR	NR	NR	
Cm-246	M	3	D	4.51E-01	FGR11	NR	NR	NR	NR	
Co-60	M	3	D	2.19E-04	FGR11	NR	NR	NR	NR	
Cs-134	M	3	D	4.62E-05	FGR11	NR	NR	NR	NR	
Cs-137	M	3	D	3.19E-05	FGR11	NR	NR	NR	NR	
Eu-152	M	3	D	2.21E-04	FGR11	NR	NR	NR	NR	
Eu-154	M	3	D	2.86E-04	FGR11	NR	NR	NR	NR	
Eu-155	M	3	D	4.14E-05	FGR11	NR	NR	NR	NR	
Gd-152	M	3	D	2.43E-01	FGR11	NR	NR	NR	NR	
H-3	M	3	D	6.40E-08	FGR11	NR	NR	NR	NR	
I-129	M	3	D	1.74E-04	FGR11	NR	NR	NR	NR	
Nb-94	M	3	D	4.14E-04	FGR11	NR	NR	NR	NR	
Nd-144[e]	M	3	D	7.04E-02	ICRP60	NR	NR	NR	NR	
Ni-59	M	3	D	2.70E-06	FGR11	NR	NR	NR	NR	
Ni-63	M	3	D	6.29E-06	FGR11	NR	NR	NR	NR	
Np-237	M	3	D	5.40E-01	FGR11	NR	NR	NR	NR	
Pa-231	M	3	D	1.28E+00	FGR11	NR	NR	NR	NR	
Pb-210	M	3	D	1.36E-02	FGR11	NR	NR	NR	NR	
Po-210	M	3	D	9.40E-03	FGR11	NR	NR	NR	NR	
Pu-238	M	3	D	3.92E-01	FGR11	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Pu-239	M	3	D	4.29E-01	FGR11	NR	NR	NR	NR	
Pu-240	M	3	D	4.29E-01	FGR11	NR	NR	NR	NR	
Pu-241	M	3	D	8.25E-03	FGR11	NR	NR	NR	NR	
Pu-242	M	3	D	4.11E-01	FGR11	NR	NR	NR	NR	
Ra-226	M	3	D	8.58E-03	FGR11	NR	NR	NR	NR	
Ra-228	M	3	D	4.77E-03	FGR11	NR	NR	NR	NR	
Sm-148[e]	M	3	D	7.34E-02	ICRP60	NR	NR	NR	NR	
Sr-90	M	3	D	1.30E-03	FGR11	NR	NR	NR	NR	
Tc-99	M	3	D	8.32E-06	FGR11	NR	NR	NR	NR	
Th-228	M	3	D	3.42E-01	FGR11	NR	NR	NR	NR	
Th-229	M	3	D	2.15E+00	FGR11	NR	NR	NR	NR	
Th-230	M	3	D	3.26E-01	FGR11	NR	NR	NR	NR	
Th232	M	3	D	1.64e+00	FGR11	NR	NR	NR	NR	
U-233	M	3	D	1.35E-01	FGR11	NR	NR	NR	NR	
U-234	M	3	D	1.32E-01	FGR11	NR	NR	NR	NR	
U-235	M	3	D	1.23E-01	FGR11	NR	NR	NR	NR	
U-236	M	3	D	1.25E-01	FGR11	NR	NR	NR	NR	
U-238	M	3	D	1.18E-01	FGR11	NR	NR	NR	NR	
Dose Conversion Factors (Ingestion mrem/pCi)										
Ac-227	M	3	D	1.41E-02	FGR11	NR	NR	NR	NR	
Am-241	M	3	D	3.64E-03	FGR11	NR	NR	NR	NR	
Am-243	M	3	D	3.62E-03	FGR11	NR	NR	NR	NR	
C-14	M	3	D	2.09E-06	FGR11	NR	NR	NR	NR	
Cm-243	M	3	D	2.51E-03	FGR11	NR	NR	NR	NR	
Cm-244	M	3	D	2.02E-03	FGR11	NR	NR	NR	NR	
Cm-245	M	3	D	3.74E-03	FGR11	NR	NR	NR	NR	
Cm-246	M	3	D	3.70E-03	FGR11	NR	NR	NR	NR	
Co-60	M	3	D	2.69E-05	FGR11	NR	NR	NR	NR	
Cs-134	M	3	D	7.33E-05	FGR11	NR	NR	NR	NR	
Cs-137	M	3	D	5.00E-05	FGR11	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Eu-152	M	3	D	6.48E-06	FGR11	NR	NR	NR	NR	
Eu-154	M	3	D	9.55E-06	FGR11	NR	NR	NR	NR	
Eu-155	M	3	D	1.53E-06	FGR11	NR	NR	NR	NR	
Gd-152	M	3	D	1.61E-04	FGR11	NR	NR	NR	NR	
H-3	M	3	D	6.40E-08	FGR11	NR	NR	NR	NR	
I-129	M	3	D	2.76E-04	FGR11	NR	NR	NR	NR	
Nb-94	M	3	D	7.14E-06	FGR11	NR	NR	NR	NR	
Nd-144[e]	M	3	D	1.51E-04	ICRP60	NR	NR	NR	NR	
Ni-59	M	3	D	2.10E-07	FGR11	NR	NR	NR	NR	
Ni-63	M	3	D	5.77E-07	FGR11	NR	NR	NR	NR	
Np-237	M	3	D	4.44E-03	FGR11	NR	NR	NR	NR	
Pa-231	M	3	D	1.06E-02	FGR11	NR	NR	NR	NR	
Pb-210	M	3	D	5.37E-03	FGR11	NR	NR	NR	NR	
Po-210	M	3	D	1.90E-03	FGR11	NR	NR	NR	NR	
Pu-238	M	3	D	3.20E-03	FGR11	NR	NR	NR	NR	
Pu-239	M	3	D	3.54E-03	FGR11	NR	NR	NR	NR	
Pu-240	M	3	D	3.54E-03	FGR11	NR	NR	NR	NR	
Pu-241	M	3	D	6.84E-05	FGR11	NR	NR	NR	NR	
Pu-242	M	3	D	3.36E-03	FGR11	NR	NR	NR	NR	
Ra-226	M	3	D	1.32E-03	FGR11	NR	NR	NR	NR	
Ra-228	M	3	D	1.44E-03	FGR11	NR	NR	NR	NR	
Sm-148[e]	M	3	D	1.58E-04	ICRP60	NR	NR	NR	NR	
Sr-90	M	3	D	1.42E-04	FGR11	NR	NR	NR	NR	
Tc-99	M	3	D	1.46E-06	FGR11	NR	NR	NR	NR	
Th-228	M	3	D	3.96E-04	FGR11	NR	NR	NR	NR	
Th-229	M	3	D	3.53E-03	FGR11	NR	NR	NR	NR	
Th-230	M	3	D	5.48E-04	FGR11	NR	NR	NR	NR	
Th-232	M	3	D	2.73E-03	FGR11	NR	NR	NR	NR	
U-233	M	3	D	2.89E-04	FGR11	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
U-234	M	3	D	2.83E-04	FGR11	NR	NR	NR	NR	
U-235	M	3	D	2.66E-04	FGR11	NR	NR	NR	NR	
U-236	M	3	D	2.69E-04	FGR11	NR	NR	NR	NR	
U-238	M	3	D	2.55E-04	FGR11	NR	NR	NR	NR	
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-134	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fe-55	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nd-144	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pm-147	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Pu-240	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sb-125	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sm-148	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Tc-99	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ag-108m	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-134	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fe-55	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Gd-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nd-144	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sb-125	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sm-148	P	1	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Tc-99	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Am-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-134	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Fe-55	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nd-144	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sm-148	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Tc-99	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Th-229	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-245	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-246	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Gd-152	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
I-129	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Pu-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-242	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-238	P	2	D	NA	Industrial Scenario	NR	NR	NR	NR	
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L))										
Ac-227	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-241	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Am-243	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
C-14	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-243	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-244	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-245	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cm-246	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Co-60	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Cs-137	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-152	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Eu-154	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Gd-152	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
H-3	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
I-129	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Nb-94	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-59	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ni-63	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Np-237	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pa-231	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pb-210	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Po-210	P	S	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-238	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-239	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-240	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-241	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Pu-242	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-226	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Ra-228	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Sr-90	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-228	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-229	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-230	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Th-232	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-233	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-234	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-235	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-236	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
U-238	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	

BFM INSITU$_{gw}$: RESRAD PARAMETERS FOR UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters[d]				
						1	2	3	4	Mean/ Median
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Notes:
a P = physical, B = behavioral, M = metabolic; (see NUREG/CR-6697, Attachment B, Table 4.)
b 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter (see NUREG/CR-6697, Attachment B, Table 4.1)
c D = deterministic, S = stochastic
d Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Beta: 1 = minimum, 2 = maximum, 3 = P-value, 4 = Q-value
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum e Sm-148 an ND-144 not listed in RESRAD FGR 11 DCF file
e Reference: Haley and Aldrich, Inc., "Hydrogeological Investigation Report La Crosse Boiling Water Reactor, Dairyland Power Cooperative, Genoa, WI" January 2015
f ZionSolutions Technical Support Document 14-003, Conestoga Rovers & Associates (CRA) Report, "Zion Hydrogeologic Investigation Report"
g Argonne National Laboratory, "User's Manual for RESRAD Version 6", ANL/EAD 4, July 2001

ATTACHMENT 6-3

RESRAD Input Parameters for LACBWR Alternate Scenario Uncertainty Analysis

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Soil Concentrations										
Basic radiation dose limit (mrem/y)		3	D	25	10 CFR 20.1402	NR	NR	NR	NR	
Initial principal radionuclide (pCi/g)	P	2	D	Varies based on Radionuclide Mixture	Unit Value	NR	NR	NR	NR	
Distribution coefficients (contaminated, unsaturated, and saturated zones) (cm^3/g)										
Ac-227 (daughter of Cm-243 and Pu-239)	P	1	D	450	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	6.72	3.22	NA	NA	825
Am-241 (also daughter of Cm-245 and Pu-241)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	7.28	3.15	NA	NA	1445
Am-243	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	7.28	3.15	NA	NA	1445
C-14	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	2.4	3.22	NA	NA	11
Cm-243	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	8.82	1.82	NA	NA	6761
Cm-244	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	8.82	1.82	NA	NA	6761
Co-60	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.46	2.53	NA	NA	235
Cs-137	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.1	2.33	NA	NA	446
Eu-152	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Eu-154	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Eu-155	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.72	3.22	NA	NA	825
Fe-55	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.34	2.67	NA	NA	209
Gd-152 (daughter for Eu-152)	P	1	D	825	Median Value NUREG/CR-6697, Att. C (No sand value listed in Table 3.9-2)	6.72	3.22	NA	NA	825
H-3	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	-2.81	0.5	NA	NA	0.06
Nb-94	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	5.94	3.22	NA	NA	380
Nd-144 (daughter for Eu-152)	P	1	D	158	RESRADv.7.0 Default Nd not listed in NUREG/CR-6697	NA	NA	NA	NA	NA
Ni-59	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.05	1.46	NA	NA	424

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	**Type[a]**	**Priority[b]**	**Treatment[c]**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters [d]**				
						1	**2**	**3**	**4**	**Mean/ Median**
Ni-63	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.05	1.46	NA	NA	424
Np-237 (also daughter for Am-241, Cm-245, and Pu-241)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	2.84	2.25	NA	NA	17
Pa-231 (daughter for Cm-243 and Pu-239)	P	1	D	550	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	5.94	3.22	NA	NA	380
Pb-210 (daughter for Pu-238)	P	1	D	270	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	7.78	2.76	NA	NA	181
Po-210 (daughter Pu-238)	P	1	D	150	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	5.20	1.68	NA	NA	181
Pu-238	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Pu-239 (also daughter for Cm-243)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Pu-240 (also daughter for Cm-244)	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Pu-241	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	6.86	1.89	NA	NA	953
Ra-226 (daughter Pu-238)	P	1	D	500	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.17	1.70	NA	NA	3533
Ra-228 (daughter Cm-244 and Pu-240)	P	1	D	500	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.17	1.70	NA	NA	3533
Sm-148 (daughter Eu-152)	P	1	D	245	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	6.72	3.22	NA	NA	825
Sr-90	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	3.45	2.12	NA	NA	32
Tc-99	P	1	S	Lognormal-N	NUREG/CR-6697 Att. C	-0.67	3.16	NA	NA	0.51
Th-228 (daughter Cm-244 and Pu-240)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.68	3.62	NA	NA	5884

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Th-229 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.68	3.62	NA	NA	5884
Th-230 (daughter Cm-246 and Pu-238)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.68	3.62	NA	NA	5884
Th-232 (daughter Cm-244 and Pu-240)	P	1	D	3200	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault	8.68	3.62	NA	NA	5884
U-233 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault C	4.84	3.13	NA	NA	126
U-234 (daughter Pu-238)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault C	4.84	3.13	NA	NA	126
U-235 (daughter Cm-243 and Pu-239)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault C	4.84	3.13	NA	NA	126
U-236 (daughter Cm-244 and Pu-240)	P	1	D	35	Mean Kd Value for sand NUREG/CR-6697, Table 3.9-2, Sheppard and Thibault C	4.84	3.13	NA	NA	126
Initial concentration of radionuclides present in groundwater (pCi/l)	P	3	D	0	No existing groundwater contamination	NR	NR	NR	NR	
Calculation Times										
Time since placement of material (y)	P	3	D	0	Start of dose calculation immediately after license termination	NR	NR	NR	NR	
Time for calculations (y)	P	3	D	0, 1, 3, 10, 30, 100, 300, 1000	RESRAD Default	NR	NR	NR	NR	
Contaminated Zone										
Area of contaminated zone (m^2)	P	2	D	7500	Size of LACBWR "Licensed Site Exclusion" (LSE) area	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	**Type[a]**	**Priority[b]**	**Treatment[c]**	**Value/Distribution**	**Basis**	**Distribution's Statistical Parameters [d]**				
						1	**2**	**3**	**4**	**Mean/ Median**
Thickness of contaminated zone (m)	P	2	D	0.15	Assumed depth of surface soil	NR	NR	NR	NR	
Length parallel to aquifer flow (m)	P	2	D	98	Diameter of 7500 m2 contaminated zone	NR	NR	NR	NR	
Does the initial contamination penetrate the water table?	NA	NA	NA	No	Contaminated zone at surface	NA	NA	NA	NA	
Contaminated fraction below water table	P	3	D	0	Contaminated zone at surface	NR	NR	NR	NR	
Cover and Contaminated Zone Hydrological Data										
Cover depth (m)	P	2	D	0	No cover	NR	NR	NR	NR	
Density of cover material	P	2	D	NA	No cover	NR	NR	NR	NR	
Cover erosion rate	P,B	2	S	Continuous Logarithmic	NUREG/CR-6697 Att. C Table 3.8-1	5E-08	0.0007	0.005	0.2	0.0015
Density of contaminated zone (g/cm^3)	P	1	D	1.76	Site specific[e]	NR	NR	NR	NR	
Contaminated zone erosion rate m/y)	P,B	2	S	Continuous Logarithmic	NUREG/CR-6697 Att. C Table 3.8-1	5E-08	0.0007	0.005	0.2	0.0015
Contaminated zone total porosity	P	2	D	0.31	Site specific[e]	NR	NR	NR	NR	
Contaminated zone field capacity	P	3	D	0.2	RESRAD default. No distribution or median value provided in NURE/CR-6697 Att. C	NR	NR	NR	NR	
Contaminated zone hydraulic conductivity (m/y)	P	2	D	34822	Site specific[e] 313 feet/day = 34822 m/y	NR	NR	NR	NR	
Contaminated zone b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Humidity in air (g/m^3)	P	3	D	7.2	Median NUREG/CR-6697 Att. C	1.98	0.334	0.001	0.999	7.2
Evapotranspiration coefficient	P	2	S	Uniform	NUREG/CR-6697 Att. C Figure 4.3-1	0.5	0.75	NR	NR	0.625
Average annual wind speed (m/s)	P	2	S	Bounded Lognormal - N	NUREG/CR-6697 Att. C Figure 4.5-1	1.445	0.2419	1.4	13	4.2

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Precipitation (m/y)	P	2	D	0.78	NUREG/CR-6697 Att. C La Crosse, WI Table 4.1-2	NR	NR	NR	NR	
Irrigation (m/y)	B	3	D	0.20	NUREG-5512, Vol. 3, Table 6-18 (Wisconsin Average) Converted 0.56 L/m^2/d to m/y	NR	NR	NR	NR	
Irrigation mode	B	3	D	NA	Overhead irrigation is common practice in U. S.	NR	NR	NR	NR	
Runoff coefficient	P	2	S	Uniform	NUREG/CR-6697 Att. C Figure 4.2-1	0.1	0.8	NR	NR	0.45
Watershed area for nearby stream or pond (m^2)	P	3	D	1.00E+06	RESRAD Default	NR	NR	NR	NR	
Accuracy for water/soil computations	-	3	D	1.00E-03	RESRAD Default	NR	NR	NR	NR	
Saturated Zone Hydrological Data										
Density of saturated zone (g/cm^3)	P	2	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Saturated zone total porosity	P	1	D	0.31	Site-specific[e]	NR	NR	NR	NR	
Saturated zone effective porosity	P	1	D	0.28	Site-specific[e]	NR	NR	NR	NR	
Saturated zone field capacity	P	3	D	0.066	Calculated values for sand soil type[f]	NR	NR	NR	NR	
Saturated zone hydraulic conductivity (m/y)	P	1	D	34822	Site-specific value[e] 313 feet/day = 34822 m/y	NR	NR	NR	NR	
Saturated zone hydraulic gradient	P	2	D	0.0045	Site-specific[e]	NR	NR	NR	NR	
Saturated zone b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Water table drop rate (m/y)	P	3	D	0	Assumed zero due to hydraulic connectivity with Mississippi river.	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS											
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]					
						1	2	3	4	Mean/ Median	
Well pump intake depth (m below water table)	P	2	S	Triangular	Site-specific distribution Existing industrial water supply wells onsite at depth of 116' and 129' below ground surface (the 129' depth equals 36.3 m below the water table). 36.3 m assumed to be maximum well depth. Minimum well depth assumed to be represented by a nominal 20' screen depth (6.1 m) starting at the maximum "seasonal" water table elevation of 629' and extending to 10' below 619' elevation where water table continuously present. Mode is assumed to be mid-point between 6.1 m and 36.3 m which is 21.2 m. Note that the site-specific distribution is reasonably similar to the NUREG-6697 distribution values of 6, 10, and 30 for the triangular distribution.	6.1	21.2	36.3	NR		
Model: Nondispersion (ND) or Mass-Balance (MB)	P	3	D	ND	Applicable to flowing groundwater	NR	NR	NR	NR		

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Well pumping rate (m^3/y)	P	2	S	530	Calculated according to method described in NUREG/CR-6697, Att. C Section 3.10 assuming 7,500 m2 land area (LACBWR site area) and Wisconsin specific irrigation rate. Resident gardener with no livestock.	NR	NR	NR	NR	
Unsaturated Zone Hydrological Data										
Number of unsaturated zone strata	P	3	D	1	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone thickness (m)	P	1	D	2.90 m	Site Specific Assumed ground surface 639' elevation, contaminated Zone thickness 0.15 m, and maximum water table elevation of 629'.	NR	NR	NR	NR	
Unsat. zone soil density (g/cm^3)	P	2	D	1.76	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone total porosity	P	2	D	0.31	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone effective porosity	P	2	D	0.28	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone field capacity	P	3	D	0.066	Calculated values for sand soil type[f]	NR	NR	NR	NR	
Unsat. zone hydraulic conductivity (m/y)	P	2	D	34822	Site-specific[e]	NR	NR	NR	NR	
Unsat. zone soil-specific b parameter	P	2	S	Lognormal-N	Site specific soil type sand NUREG/CR-6697 Att. C Table 3.5-1	-.0253	0.216	NA	NA	0.97
Occupancy										
Inhalation rate (m^3/y)	M,B	3	D	8400	NUREG/CR-5512, Vol. 3 Table 6.29 (23 m^3/d x 365 d)	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Mass loading for inhalation (g/m^3)	P,B	2	S	Continuous Linear	NUREG/CR-6697, Att. C	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	See NUREG-6697 Table 4.6-1	2.35E-05
Exposure duration	B	3	D	30	RESRAD User's Manual parameter value not used in dose calculation	NR	NR	NR	NR	
Indoor dust filtration factor	P,B	2	S	Uniform	NUREG/CR-6697, Att. C Figure 7.1-1	0.15	0.95	NR	NR	0.55
Shielding factor, external gamma	P	2	S	Bounded Lognormal-N	NUREG/CR-6697, Att. C Table 7.10-1	-1.3	0.59	0.044	1	0.2725
Fraction of time spent indoors	B	3	D	0.649	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Fraction of time spent outdoors (on site)	B	3	D	0.124	NUREG/CR-5512, Vol. 3 Table 6.87 (outdoors + gardening)	NR	NR	NR	NR	
Shape factor flag, external gamma	P	3	D	Circular	Circular contaminated zone assumed for modeling purposes	NR	NR	NR	NR	
Ingestion, Dietary										
Fruits, non-leafy vegetables, grain consumption (kg/y)	M,B	2	D	112	NUREG/CR-5512, Vol. 3 (other vegetables + fruits + grain) Table 6.87	NR	NR	NR	NR	
Leafy vegetable consumption (kg/y)	M,B	3	D	21.4	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Milk consumption (L/y)	M,B	2	D	NA	No Livestock	NR	NR	NR	NR	
Meat and poultry consumption (kg/y)	M,B	3	D	NA	No Livestock	NR	NR	NR	NR	
Fish consumption (kg/y)	M,B	3	D	NA	No Fish consumption	NR	NR	NR	NR	
Other seafood consumption (kg/y)	M,B	3	D	NA	No Seafood consumption	NR	NR	NR	NR	
Soil ingestion rate (g/y)	M,B	2	D	18.3	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Drinking water intake (L/y)	M,B	2	D	478	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Contamination fraction of drinking water	B,P	3	D	1	All water assumed contaminated	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Contamination fraction of household water (if used)	B,P	3		NA	Only applicable to radon pathway					
Contamination fraction of livestock water	B,P	3	D	NA	No Livestock	NR	NR	NR	NR	
Contamination fraction of irrigation water	B,P	3	D	1	All water assumed contaminated	NR	NR	NR	NR	
Contamination fraction of aquatic food	B,P	2	D	NA	No aquatic food ingestion	NR	NR	NR	NR	
Contamination fraction of plant food	B,P	3	D	1	NUREG/CR-5512, Table 6.87 ingestion rates assumes source is residential garden	NR	NR	NR	NR	
Contamination fraction of meat	B,P	3	D	NA	No Livestock	NR	NR	NR	NR	
Contamination fraction of milk	B,P	3	D	NA	No Livestock	NR	NR	NR	NR	
Ingestion, Non-Dietary										
Livestock fodder intake for meat (kg/day)	M	3	D	NA	No Livestock	NR	NR	NR	NR	
Livestock fodder intake for milk (kg/day)	M	3	D	NA	No Livestock	NR	NR	NR	NR	
Livestock water intake for meat (L/day)	M	3	D	NA	No Livestock	NR	NR	NR	NR	
Livestock water intake for milk (L/day)	M	3	D	NA	No Livestock	NR	NR	NR	NR	
Livestock soil intake (kg/day)	M	3	D	NA	No Livestock	NR	NR	NR	NR	
Mass loading for foliar deposition (g/m^3)	P	3	D	4.00E-04	NUREG/CR-5512, Vol. 3 Table 6.87, gardening	NR	NR	NR	NR	
Depth of soil mixing layer (m)	P	2	S	Triangular	NUREG/CR-6697, Att. C Figure 3.12-1	0	0.15	0.6	NR	0.15
Depth of roots (m)	P	1	S	Uniform	NUREG/CR-6697, Att. C	0.3	4.0			2.15
Drinking water fraction from ground water	B,P	3	D	1	All water assumed to be supplied from groundwater	NR	NR	NR	NR	
Household water fraction from ground water (if used)	B,P	3	D	NA	Only applicable to radon pathway	NR	NR	NR	NR	
Livestock water fraction from ground water	B,P	3	D	NA	No Livestock	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Irrigation fraction from ground water	B,P	3	D	1	All water assumed to be supplied from groundwater	NR	NR	NR	NR	
Wet weight crop yield for Non-Leafy (kg/m^2)	P	2	S	Truncated Lognormal - N	NUREG/CR-6697, Att. C	0.56	0.48	0.001	0.999	1.75
Wet weight crop yield for Leafy (kg/m^2)	P	3	S	2.89	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Wet weight crop yield for Fodder (kg/m^2)	P	3	D	NA	Industrial Scenario	NR	NR	NR	NR	
Growing Season for Non-Leafy (y)	P	3	D	0.246	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Growing Season for Leafy (y)	P	3	D	0.123	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Growing Season for Fodder (y)	P	3	D	NA	No Livestock	NR	NR	NR	NR	
Translocation Factor for Non-Leafy	P	3	D	0.1	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Translocation Factor for Leafy	P	3	D	1	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Translocation Factor for Fodder	P	3	D	NA	No Livestock	NR	NR	NR	NR	
Weathering Removal Constant for Vegetation (1/y)	P	2	S	Triangular	NUREG/CR-6697, Att. C	5.1	18	84		33
Wet Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Wet Foliar Interception Fraction for Leafy Vegetables	P	2	S	Triangular	NUREG/CR-6697, Att. C	0.06	0.67	0.95		0.58
Wet Foliar Interception Fraction for Fodder	P	3	D	NA	No Livestock	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Non-Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Leafy	P	3	D	0.35	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Dry Foliar Interception Fraction for Fodder	P	3	D	NA	No Livestock	NR	NR	NR	NR	
Storage times of contaminated foodstuffs (days):										
Fruits, non-leafy vegetables, and grain	B	3	D	14	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	
Leafy vegetables	B	3	D	1	NUREG/CR-5512, Vol. 3 Table 6.87	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Milk	B	3	D	NA	No Livestock	NR	NR	NR	NR	
Meat and poultry	B	3	D	NA	No Livestock	NR	NR	NR	NR	
Fish	B	3	D	NA	No Aquatic Food Consumption	NR	NR	NR	NR	
Crustacea and mollusks	B	3	D	NA	No Aquatic Food Consumption	NR	NR	NR	NR	
Well water	B	3	D	1	RESRAD User's Manual Table D.6	NR	NR	NR	NR	
Surface water	B	3	D	1	RESRAD User's Manual Table D.6	NR	NR	NR	NR	
Livestock fodder	B	3	D	NA	No Livestock	NR	NR	NR	NR	
Special Radionuclides (C-14)										
C-12 concentration in water (g/cm^3)	P	3	D	NA	NA	NR	NR	NR	NR	
C-12 concentration in contaminated soil (g/g)	P	3	D	NA	NA	NR	NR	NR	NR	
Fraction of vegetation carbon from soil	P	3	D	NA	NA	NR	NR	NR	NR	
Fraction of vegetation carbon from air	P	3	D	NA	NA	NR	NR	NR	NR	
C-14 evasion layer thickness in soil (m)	P	2	D	NA	NA	NR	NR	NR	NR	
C-14 evasion flux rate from soil (1/sec)	P	3	D	NA	NA	NR	NR	NR	NR	
C-12 evasion flux rate from soil (1/sec)	P	3	D	NA	NA	NR	NR	NR	NR	
Fraction of grain in beef cattle feed	B	3	D	NA	NA	NR	NR	NR	NR	
Fraction of grain in milk cow feed	B	3	D	NA	NA	NR	NR	NR	NR	
Dose Conversion Factors (Inhalation mrem/pCi)										
All Nuclides (except two listed below)	M	3	D	Values in RESRAD "FGR 11" DCF File	FGR11	NR	NR	NR	NR	
Nd-144[e]	M	3	D	7.04E-02	ICRP 107	NR	NR	NR	NR	
Sm-148[e]	M	3	D	7.34E-02	ICRP 107	NR	NR	NR	NR	
Dose Conversion Factors (Ingestion mrem/pCi)										
All Nuclides (except two listed below)	M	3	D	Values in RESRAD "FGR 11" DCF File	FGR11	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Nd-144[e]	M	3	D	1.51E-04	ICRP107	NR	NR	NR	NR	
Sm-148[e]	M	3	D	1.58E-04	ICRP107	NR	NR	NR	NR	
Plant Transfer Factors (pCi/g plant)/(pCi/g soil)										
Ac-227	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	1.1	NR	NR	9.98E-04
Am-241	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Am-243	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
C-14	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-0.36	0.9	NR	NR	6.98E-01
Cm-243	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Cm-244	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Co-60	P	1	S	Lognormal - N	NUREG/CR-6697, Att. C	-2.53	0.9	NR	NR	7.97E-02
Cs-134	P	1	S	Lognormal - N	NUREG/CR-6697, Att. C	-3.22	1.0	NR	NR	4.00E-02
Cs-137	P	1	S	Lognormal - N	NUREG/CR-6697, Att. C	-3.22	1.0	NR	NR	4.00E-02
Eu-152	P	1	S	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.1	NR	NR	2.01E-03
Eu-154	P	1	S	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.1	NR	NR	2.01E-03
Eu-155				Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.1	NR	NR	2.01E-03
Fe-55	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Gd-152	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.1	NR	NR	2.01E-03
H-3	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	1.57	1.1	NR	NR	4.81E+00
Nb-94	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-4.61	1.1	NR	NR	9.95E-03
Nd-144	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.0	NR	NR	2.01E-03
Ni-59	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-3.00	0.9	NR	NR	4.98E-02
Ni-63	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-3.00	0.9	NR	NR	4.98E-02
Np-237	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-3.91	0.9	NR	NR	2.00E-02
Pa-231	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-4.61	1.1	NR	NR	9.95E-03
Pb-210	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-5.52	0.9	NR	NR	4.01E-03
Pm-147	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.1	NR	NR	2.01E-03
Po-210	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.9	0.9	NR	NR	1.01E-03
Pu-238	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Pu-239	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Pu-240	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Pu-241	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Ra-226	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-3.22	0.9	NR	NR	4.00E-02
Ra-228	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-3.22	0.9	NR	NR	4.00E-02
Sb-125	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-4.61	1.0	NR	NR	9.95E-03
Sm-148	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	1.1	NR	NR	2.01E-03
Sr-90	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-1.20	1.0	NR	NR	3.01E-01
Tc-99	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	1.61	0.9	NR	NR	5.00E+00
Th-228	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Th-229	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Th-230	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
Th-232	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.91	0.9	NR	NR	9.98E-04
U-233	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	0.9	NR	NR	2.01E-03
U-234	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	0.9	NR	NR	2.01E-03
U-235	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	0.9	NR	NR	2.01E-03
U-236	P	1	D	Lognormal - N	NUREG/CR-6697, Att. C	-6.21	0.9	NR	NR	2.01E-03
Meat Transfer Factors (pCi/kg)/(pCi/d)										
Ac-227	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Ag-108m	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Am-241	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Am-243	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
C-14	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Co-60	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS											
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]					
						1	2	3	4	Mean/ Median	
Cs-134	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Cs-137	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Eu-152	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Eu-154	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Fe-55	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Gd-152	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
H-3	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Nb-94	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Nd-144	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Ni-59	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Ni-63	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Np-237	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Pa-231	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Pb-210	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Po-210	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Pu-238	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Pu-239	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Pu-240	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Pu-241	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		
Ra-226	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR		

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Ra-228	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Sb-125	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Sm-148	P	1	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Tc-99	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-228	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-229	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-230	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-232	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-233	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-234	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-235	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-236	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Milk Transfer Factors (pCi/L)/(pCi/d)										
Ac-227	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Am-241	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Am-243	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
C-14	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Cm-243	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Cm-244	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Co-60	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Cs-134	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Cs-137	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Eu-152	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Eu-154	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Fe-55	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Gd-152	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
H-3	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Nb-94	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Nd-144	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Ni-59	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Ni-63	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Np-237	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Pa-231	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Pb-210	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Po-210	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Pu-238	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Pu-239	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Pu-240	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Pu-241	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Ra-226	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Ra-228	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Sm-148	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Sr-90	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Tc-99	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-228	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-229	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-230	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Th-232	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-233	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-234	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-235	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
U-236	P	2	D	NA	Resident Gardener No Livestock	NR	NR	NR	NR	
Bioaccumulation Factors for Fish ((pCi/kg)/(pCi/L))										
Ac-227 (daughter of Cm-243 and Pu-239)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Am-241 (also daughter of Pu-241)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Am-243	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
C-14	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Cm-243	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Cm-244	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Co-60	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Cs-137	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Eu-152	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
Eu-154	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Eu-155	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Fe-155	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Gd-152 (daughter of Eu-152)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
H-3	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Nb-94	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Nd-144 (daughter of Eu-152)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Ni-59	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Ni-63	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Np-237 (also daughter of Am-241, Cm-245, and Pu-241)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Pa-231 (daughter of Cm-243 and Pu-239)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Pb-210 (daughter of Pu-238)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Po-210 (daughter of Pu-238)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Pu-238	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Pu-239 (also daughter of Cm-243)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Pu-240 (also daughter of Cm-244)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Pu-241	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Ra-226 (daughter of Pu-238)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Ra-228 (daughter of Cm-244 and Pu-240)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Sm-148 (daughter Eu-152)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Sr-90	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Tc-99	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Th-228 (daughter Cm-244 and Pu-240)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Th-229 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Th-230 (daughter Cm-246 and Pu-238)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	
Th-232 (daughter Cm-244 and Pu-240)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR	

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS											
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]					
						1	2	3	4	Mean/ Median	
U-233 (daughter Am-241, Cm-245, Np-237, and Pu-241)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR		
U-234 (daughter Pu-238)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR		
U-235 (daughter Cm-243 and Pu-239)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR		
U-236 (daughter Cm-244 and Pu-240)	P	2	D	NA	No Fish Consumption	NR	NR	NR	NR		
Bioaccumulation Factors for Crustacea/ Mollusks ((pCi/kg)/(pCi/L))											
Ac-227	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Am-241	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Am-243	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
C-14	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Cm-243	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Cm-244	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Cm-245	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Cm-246	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Co-60	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Cs-137	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Eu-152	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Eu-154	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Gd-152	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
H-3	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
I-129	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Nb-94	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS											
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]					
						1	2	3	4	Mean/ Median	
Ni-59	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Ni-63	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Np-237	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pa-231	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pb-210	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Po-210	P	S	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pu-238	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pu-239	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pu-240	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pu-241	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Pu-242	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Ra-226	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Ra-228	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Sr-90	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Th-228	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Th-229	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Th-230	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
Th-232	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
U-233	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		
U-234	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR		

ALTERNATE SCENARIO RESIDENT GARDENER RESRAD INPUT PARAMETERS INITIAL SUITE RADIONUCLIDES UNCERTAINTY ANALYSIS										
Parameter (unit)	Type[a]	Priority[b]	Treatment[c]	Value/Distribution	Basis	Distribution's Statistical Parameters [d]				
						1	2	3	4	Mean/ Median
U-235	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR	
U-236	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR	
U-238	P	3	D	NA	No Crustacea/Mollusks Consumption	NR	NR	NR	NR	
Graphics Parameters										
Number of points				32	RESRAD Default	NR	NR	NR	NR	
Spacing				log	RESRAD Default	NR	NR	NR	NR	
Time integration parameters										
Maximum number of points for dose				17	RESRAD Default	NR	NR	NR	NR	

Notes:
a P = physical, B = behavioral, M = metabolic; (see NUREG/CR-6697, Attachment B, Table 4.1)
b 1 = high-priority parameter, 2 = medium-priority parameter, 3 = low-priority parameter (see NUREG/CR-6697, Attachment B, Table 4.1)
c D = deterministic, S = stochastic
d NUREG/CR-6697 Distributions Statistical Parameters:
Lognormal-n: 1= mean, 2 = standard deviation
Bounded lognormal-n: 1= mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Truncated lognormal-n: 1= mean, 2 = standard deviation, 3 = lower quantile, 4 = upper quantile
Bounded normal: 1 = mean, 2 = standard deviation, 3 = minimum, 4 = maximum
Beta: 1 = minimum, 2 = maximum, 3 = P-value, 4 = Q-value
Triangular: 1 = minimum, 2 = mode, 3 = maximum
Uniform: 1 = minimum, 2 = maximum e Sm-148 an ND-144 not listed in RESRAD FGR 11 DCF file
e Haley and Aldrich, Inc., "Hydrogeological Investigation Report La Crosse Boiling Water Reactor, Dairyland Power Cooperative, Genoa, WI" January 2015
f ZionSolutions Technical Support Document 14-003, Conestoga Rovers & Associates (CRA) Report, "Zion Hydrogeologic Investigation Report"
g Argonne National Laboratory, "User's Manual for RESRAD Version 6", ANL/EAD 4, July 2001