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NSDF ECOLOGICAL RISK ASSESSMENT

232-121240-ASD-001

Revision 1

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S. Faught
Manager, NSDF Regulatory Approval

Date

Canadian Nuclear Laboratories

Near Surface Disposal Facility

ECOLOGICAL RISK ASSESSMENT (RADIOLOGICAL & NON-RADIOLOGICAL) FOR THE NSDF POST-CLOSURE PHASE

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ITERATION HISTORY

Iteration		Details of Iteration	Author	Reviewer
No	Date			
Revision 1 of 3rd Iteration	September 2020	Update of “Iteration #3” to additionally include environmental media criteria and dose criteria from Quebec.	Helen Manolopoulos Xin Tong	Xin Tong Ryan Kovacs Helen Manolopoulos
Iteration #3	November 2019	Submitted Radiological and Non-Radiological EcoRA for PostSA Iteration #3. Main updates included: • Assessing radiological and non-radiological exposures to non-human biota using maximum predicted concentrations in environmental media predicted in the PostSA Iteration #3 • Expanding the number of scenarios to include all new scenarios from PostSA Iteration #3 • Updating COPC screening methodology for radionuclides to only use environmental screening criteria consistent with UNSCEAR (2008) • Updating dose coefficients from ERICA Tool • Adding moose as an ecological receptor	Nava Garisto Helen Manolopoulos Mo-Ki Tai	Ryan Kovacs
Iteration #2 (also referred to as “Addendum 2”)	February 2019	Submitted Non-Radiological HHERA for PostSA Iteration #2	Helen Manolopoulos Mo-Ki Tai	Jordan Gilbert
Iteration #2 (also referred to as “Addendum 2”)	November 2018	Submitted Radiological EcoRA for PostSA Iteration #2	Nava Garisto Helen Manolopoulos Mo-Ki Tai	Ryan Kovacs

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ACRONYMS AND ABBREVIATIONS

AECL	Atomic Energy of Canada Limited
ATSDR	Agency for Toxic Substances and Disease Registry
BW	Body Weight
CCME	Canadian Council of Ministers of the Environment
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COPC	Constituent of Potential Concern
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSM	Conceptual Site Model
CWF	Canadian Wildlife Federation
DC	Dose Coefficient
DOE	Department of Energy
DW	Dry weight
ECM	Engineered Containment Mound
EcoRA	Ecological Risk Assessment
EEC	Environmental Effect Concentration
EIS	Environmental Impact Statement
EMC	Environmental Media Concentrations
END	Endangered
EPA	Environmental Protection Agency
EPC	Exposure Point Concentration
FASSET	Framework for Assessment of Environmental Impact
FCSAP	Federal Contaminated Sites Assessment Program
FW	Fresh Weight
HER	Hydrologically Effective Rainfall
IAEA	International Atomic Energy Agency
IC	Institutional Control
ISQG	Interim Sediment Quality Guideline
LEL	Lowest Effect Level
LOEC	Lowest Observable Effects Concentration
LOAEL	Lowest Observed Adverse Effect Level
MECP	Ministry of Environment, Conservation and Parks (Ontario)
MELCC	Ministère de l'Environnement et de la Lutte contre les changements climatiques
MNRF	Ministry of Natural Resources and Forestry
NCRP	National Council on Radiation Protection and Measurements
NEC	No-Effects Concentration
NES	Normal Evolution Scenario

NOAEL	No Observed Adverse Effect Level
NOEC	No Observable Effects Concentration
NSDF	Near Surface Disposal Facility
OMOE	Ontario Ministry of the Environment
OMOECC	Ontario Ministry of the Environment and Climate Change
OMOEE	Ontario Ministry of the Environment and Energy
PCW	Perch Creek at the Weir
PostSA	Post-closure Safety Assessment
RBE	Relative Biological Effectiveness
SA	Sensitivity Analysis
SARA	*Species at Risk Act*
SC	Special Concern
SI	Screening Index
TF	Transfer Factor
THR	Threatened
TRV	Toxicity Reference Value
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VC	Valued Component
WNS	White-nose Syndrome
WW	Wet Weight

1 INTRODUCTION

Canadian Nuclear Laboratories (CNL, acting on behalf of Atomic Energy of Canada Limited, AECL) is proposing the construction of a Near Surface Disposal Facility (NSDF). In support of this project (NSDF Project), a Post-closure Safety Assessment (PostSA) was undertaken. Using the results of the PostSA, which are documented in the PostSA Report (Arcadis and Quintessa 2019), an Ecological Risk Assessment (EcoRA) was conducted to assess exposures of non-human biota to radiological and non-radiological contaminants during the post-closure phase of the NSDF Project.

1.1 Scope of Ecological Risk Assessment

As noted above, an EcoRA was conducted to assess exposures of non-human biota to radiological and non-radiological contaminants during the post-closure phase of the NSDF Project based on the scenarios considered in the PostSA (Arcadis and Quintessa 2019). All contaminant (radiological and non-radiological) concentrations used in the EcoRA were obtained from the PostSA. The PostSA scenarios that were considered in the EcoRA include a Normal Evolution Scenario (NES) along with several sensitivity cases, Disruptive Event, Defence-in-Depth and "What-If" scenarios, and scenarios examining Dose Optimization.

The NES is a reference description of the expected evolution of the engineered containment mound (ECM), its surroundings, and its resulting releases. A range of sensitivity analyses were also completed based on the NES, to directly examine the effects of important uncertainties in the data and models that were used to represent the NSDF system in the PostSA. The NES is summarized as follows (Arcadis and Quintessa 2019):

> In the NES, the facility is assumed to be closed as planned, with no unforeseen events. A 300-year period of institutional control (IC) is initiated, during which the facility remains under surveillance and control. After the 300-year IC period, restrictions on the use of the land are assumed to be forgotten, thereby allowing access to the site. The engineered barriers degrade as expected.
>
> The climate is assumed to evolve according to the current scientific consensus on climate change, including temperature and precipitation increases.
>
> Initially the wastes will remain mostly unsaturated. Some radioactive and non-radioactive contaminants will dissolve into pore water, but there will be no significant flow out of the ECM.
>
> Corrosion of steel liners and degradation of organic wastes will generate bulk gases containing H-3, Rn-222, and C-14. These gases will be released to the atmosphere and soil via defects in the geomembrane.
>
> As the cover degrades, water levels within the ECM will increase. Contaminants will disperse depending on flow, solubility, and sorption properties. Increased water levels will promote corrosion and organic degradation. Water will be released through the bottom of the ECM to the creek bed of Perch Creek. If water levels rise above the level of the berm, there may be a pathway for release of dissolved contaminants to the surface environment (e.g., soil and surface water).

Disruptive Event scenarios encompass disruptions of the site, system, or surroundings, as well as intrusion scenarios. Scenarios in this group involve variations – e.g., principal parameter values, environmental changes, and human intrusions – that could challenge the integrity of the ECM and thus enhance potential exposures. Dose optimization scenarios examine alternative operational practices or strategies during the closure of the facility and evaluate the effects on safety performance. Defence-in-Depth scenarios are aimed at building confidence in the performance of the NSDF after closure. Specifically, they examine the extent to which the NSDF depends on key engineered barriers and what would happen if these barriers were not present. Finally, “What-If” scenarios represent a deliberately extreme set of assumptions than can be used to understand absolute limits of safety performance. The likelihood of occurrence of “What-If” scenarios is very low or negligible (Arcadis and Quintessa 2019).

The underlying conceptual model for each scenario is generally the same as that for the NES, but the selection of scenario-related parameters affecting the predictions differ in each case. Detailed descriptions of the scenarios are provided in the PostSA Report (Arcadis and Quintessa 2019).

The post-closure scenarios that were assessed in the EcoRA are summarized in Table 1-1. As seen from the table, the PostSA included four Human Intrusion scenarios to assess the effects from:

- digging a borehole into the waste (scenario 2);
- excavating a basement for a residence placed on top of the ECM (scenario 3);
- mass excavation of the NSDF and placement of the entire inventory in surface soils (scenario 15);
- obtaining water from a shallow well intersecting the contaminant plume (scenario 16).

The post-closure scenarios also include three “What-If” scenarios, human intrusion scenarios (15) and (16) noted above as well as scenario (17) examining the impacts of a permanent bathtub condition within the ECM.

Human Intrusion scenarios (2) and (16) are not relevant to the EcoRA and were not assessed. Scenarios (3) and (15) however, were included for assessment in the EcoRA because in scenario (3), the material excavated from the ECM to create the basement is placed over the garden area of the residence where biota may become exposed to contaminants and in scenario (15), the excavated NSDF inventory is spread over surface soils in the area where biota may become exposed to contaminants. The NES sensitivity analyses examining the potential doses to downstream resident receptors that obtain their water from the Ottawa River (scenario 1g) and to the Indigenous receptor (scenario 1h) as well as scenario (10) on radon optimization, are also not relevant to the EcoRA and were not assessed. Scenario (9) examines the potential long-term effects of implementing land use restrictions that are adhered to by people; non-human biota are not expected to adhere to any land use restrictions and thus for non-human biota this scenario is equivalent to the Normal Evolution Scenario.

Table 1-1 Summary of PostSA Scenarios and those Assessed in the EcoRA

No.	PostSA Scenario	Description / Change from NES	Assessed in EcoRA?
	Normal Evolution and Sensitivity Analyses (SAs)		
1	Normal Evolution Scenario (NES)	A reference description of the expected evolution of the engineered containment mound (ECM), its surroundings, and its resulting releases.	Yes
1(a)	SA: Inventory Sensitivity	Examines alternative starting inventories and their effects on the performance of the system.	Yes
1(b)	SA: Institutional Control Sensitivity	Examines the impact of a shorter Institutional Control (IC) period of only 100 years (ending in the year 2200) as opposed to 300 years (ending in the year 2400).	Yes
1(c)	SA: Sorption Coefficient Sensitivity	Examines the use of alternative sorption coefficients that have been adjusted by an order of magnitude.	Yes
1(d)	SA: Geosphere – Rapid Transit to Perch Creek	Examines the impact of reduced transit time from the ECM to Perch Creek, where a lower transit time of 5 years is used, rather than the average transit time of 7 years.	Yes
1(e)	SA: Enhanced Degradation of Cover and Liner	Examines alternative timings and rates of degradation of the engineered barriers. Alternative timings include, for example, potential impacts resulting from the degradation of engineered barriers starting at an earlier point – before the end of their planned designed life. Alternative rates include, for example, accelerated degradation of the barriers – beyond their postulated degradation rates.	Yes
1(f)	SA: Global Warming – Reduced HER	Examines the impact of reduced hydrologically effective rainfall (HER) (i.e., rainfall minus evapotranspiration) on the system, which may result if increased temperatures produce increased evapotranspiration rates.	Yes
1(g)	SA: - Receptors of Public Interest	Examines the potential impacts of the facility on additional (human) receptor locations that are not of interest based on public feedback received on the project. Specifically, it examines the potential doses to resident receptors that obtain their water from the Ottawa River.	No
1(h)	SA: Self-Sufficient Indigenous Receptor	This scenario is the same as the NES yielding the same contaminant concentrations in the environment but additionally assesses an Indigenous receptor that relies on harvesting plants and animals.	No
	Disruptive Events		
2	Human Intrusion, Borehole Drilling (Acute)	In this scenario, a borehole is installed into the NSDF, which intersects the buried waste. It is assumed that the drill does not deflect around barriers, containers, or waste forms, nor does the driller recognize that something is wrong to cease operation. This scenario examines the radioactive dose received by the drill	No

No.	PostSA Scenario	Description / Change from NES	Assessed in EcoRA?
		operator (driller). The scenario is assumed to occur at the end of the IC period, i.e., at year 2400. The receptor in this scenario receives a dose from the exhumed material while operating the drilling machinery.	
3	Human Intrusion, House with Basement – Resident (Chronic)	In this scenario the resident/farmer is assumed to construct their residence on top of the ECM despite the undesirable nature of its overall slope and contoured cover, and, is assumed to have excavated and built a basement for their residence. It is also assumed that the excavated material is spread throughout the garden area and is used to grow garden produce. This scenario examines the radioactive dose received by the resident/farmer receptor. The scenario is assumed to occur at year 2400, once the IC period has ended.	Yes
4	Enhanced Erosion Case	This scenario examines accelerated erosion of the cover compared to the NES. This could be caused for example, by much wetter climate conditions, severe earthquake damage, or other causes. The ECM will erode over time and be deposited into the swamp, and eventually the creek and downstream into the Ottawa River.	Yes
5	Localized Cover Failure	This scenario investigates the effects of a localized failure developing in the cover of the facility. This failure could result from a number of different initiating events, including settling of the waste and earthquake. This is conservatively assumed to occur immediately following the end of the IC period, i.e., at 300 years post-closure at year 2400. The failure of the cover results in additional infiltration and much greater water flow through the shallow wastes and spills over the berm earlier than in the NES. The assumed size and location of the failure is conservative.	Yes
6	Localized Liner Failure	This scenario investigates the effects of a localized failure developing in the liner of the facility. This failure could result from a number of different initiating events, including settling of the waste and earthquake. This is conservatively assumed to occur immediately following the end of the IC period, i.e., at 300 years post-closure at year 2400. The leached contaminants that accumulate in the low point of the liner will be discharged through the failure.	Yes
7	Damage to Berm	This scenario investigates the effects of damage to the downslope berm on the performance of the facility. This failure could potentially result, for example, from a	Yes

No.	PostSA Scenario	Description / Change from NES	Assessed in EcoRA?
		severe seismic event. The damage is assumed to affect its height (and therefore the amount of contaminated water that overtops it during bathtubbing), as well as its ability to anchor the cover and liner layers. This results in transport of contaminants downgradient.	
	Dose Optimization		
8	Waste Packages – Wastes Grouted into Steel Liners	Examines the effect of considering the protective action of steel liners or their grout fill, which are not credited in the reference case (i.e., NES).	Yes
9	Confidence in Land Use Restrictions	Examines the potential effects of long-term land use restrictions being put in place and adhered to (as opposed to forgotten allowing receptors to be present on-site as in the NES).	Yes
10	Radon Optimization Through Waste Placement	Examines the potential for dose optimization by emplacing radon generating waste deeper in the ECM or limiting concentrations of radon generating radionuclides in the upper layers of the ECM.	No
	Defence-in-Depth		
11	Role of Geosphere	This scenario is based on the NES but assumes that the geosphere distribution coefficients (K_d values) are equal to zero for all radionuclides. This scenario highlights the role of the geosphere as a barrier.	Yes
12	Role of Cover	This scenario is based on the NES but is designed to assess the importance of the cover of the system. The cover is assumed to be completely absent at the time of closure, allowing increased water ingress into the facility. In contrast, the base liner is assumed to behave as expected, as in the NES. Bathtubbing will occur much sooner due to the increase in water ingress.	Yes
13	Role of Base Liner	This scenario is based on the NES but is designed to assess the importance of the base liner on the system. The base liner is assumed to completely fail at the time of closure, allowing water to leach out of the facility. The cover is assumed to behave as expected, as in the NES. Due to increased leaching out of the facility, bathtubbing will not occur.	Yes
14	Series of Landslides	This scenario is based on the NES but is designed to assess the importance of the berm. It is assumed that a series of landslides have occurred over a long period of time, resulting in material being transported downslope. This will result in waste being exposed, as well as the ability for water to escape the facility without bathtubbing (since the berm is not present and the liner is no longer anchored and cannot contain the water).	Yes

No.	PostSA Scenario	Description / Change from NES	Assessed in EcoRA?
	"What-If"		
15	Human Intrusion, Mass Excavation and Farming	Examines the consequences of the complete disruption and excavation of the NSDF inventory where the entire inventory is dispersed in surface soils (with minimal dilution), which are subsequently used, for example, for cultivating foods. This scenario maximizes the number of exposure pathways to the resident/farmer receptor in the PostSA.	Yes
16	Human Intrusion, Well Case (shallow contaminated well)	In this scenario, the (human) receptor obtains their water from a shallow well that intersects the contaminant plume. This scenario addresses the uncertainty surrounding where future (human) receptors may obtain their water from. The additional pathways include drinking well water and irrigating with well water from the shallow well, and the farmer giving well water, instead of creek water, to the animals.	No
17	Permanent Bathtub	Examines the impacts of bathtub conditions arising within the ECM but not subsiding (thus, permanent bathtubbing), whether by slower than anticipated degradation of the liner system, or by clogging with fine particulate. The leachate collection system that is built into the facility is assumed to be sealed prior to the end of the IC period.	Yes

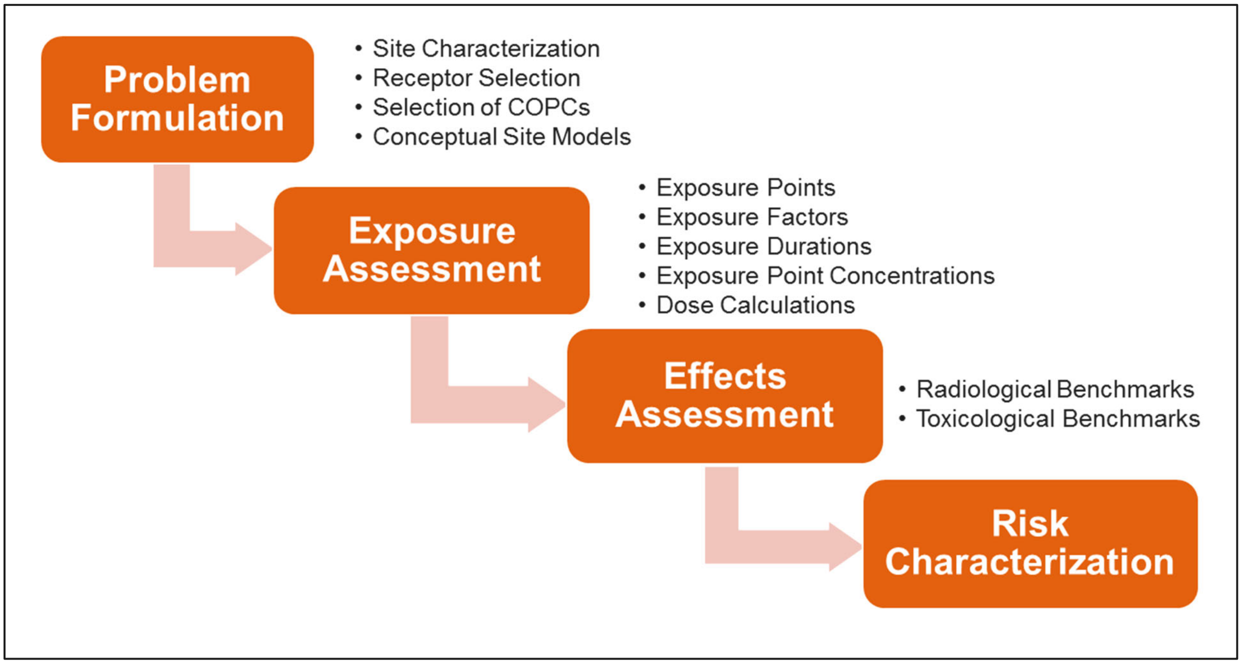
1.2 Report Outline

The EcoRA was completed based on data/model predictions available from PostSA (Arcadis and Quintessa 2019). The assessment follows the Canadian Standards Association (CSA) N288.6-12 standard process/framework (CSA 2012), as shown in Figure 1-1. The report is structured as follows:

- **Problem Formulation** – Section 2
- **Exposure Assessment** – Section 3
- **Effects Assessment** – Section 4
- **Risk Characterization** – Section 5
- **Uncertainties** – Section 6
- **Summary and Conclusions** – Section 7
- **References** – Section 8

Uncertainties are discussed in Section 6 as per N288.6-12 (CSA 2012) Section 8, and consistent with REGDOC 2.11.1 (CNSC 2018).

Figure 1-1 Technical Components in EcoRA in Accordance with N288.6-12 Framework



2 PROBLEM FORMULATION

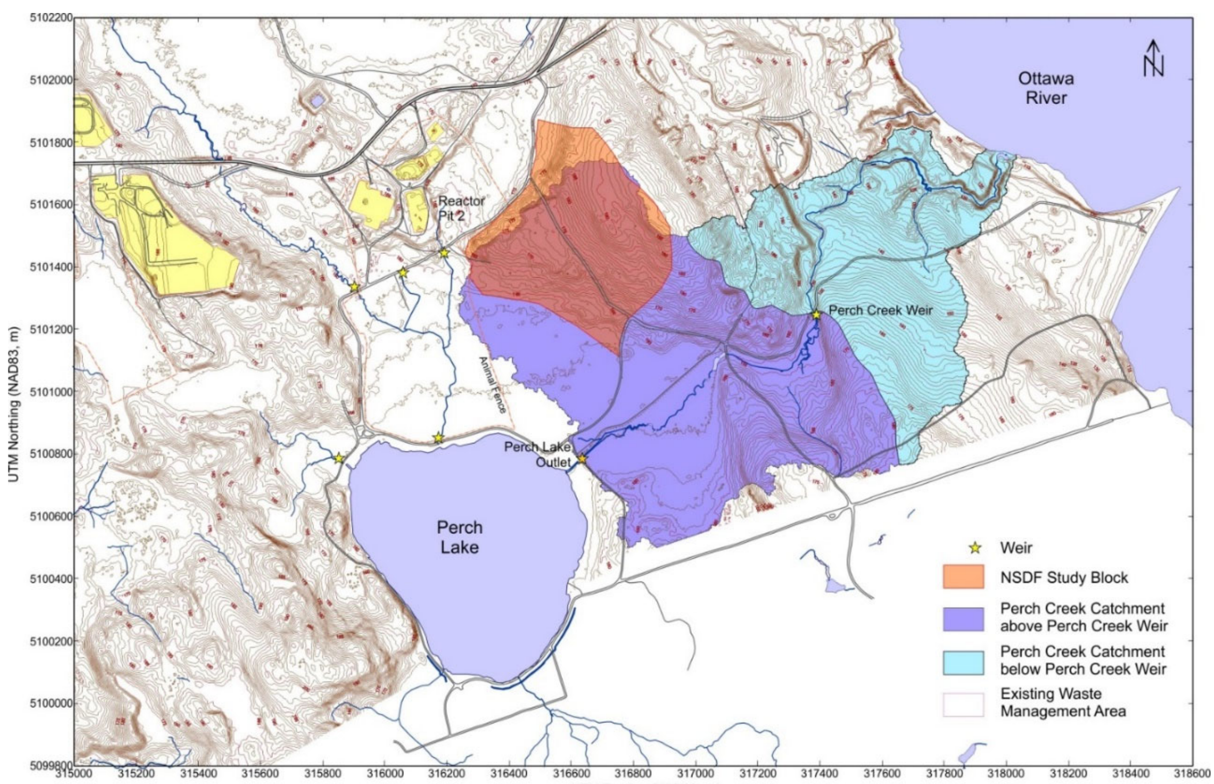
2.1 Site Description

The proposed NSDF Project is located entirely within the Chalk River Laboratories (CRL) property in Renfrew County, Ontario. The CRL property is located on the west shore of the Ottawa River, which is the dominant drainage feature in the area. The NSDF site is situated northeast of Perch Lake and adjacent to the Perch Lake wetlands, which occupy most of the low-relief region. These wetlands are a significant feature of the surface hydrology of the Lower Perch Lake Basin to the west and south of the NSDF. The wetland immediately to the west of the NSDF site is called East Swamp and connects to Perch Lake via East Swamp Stream and Main Stream. Perch Lake Swamp is located between the NSDF and Perch Lake. These wetlands are predominantly forested swamps, which contain small, wetter areas where in some locations shallow open water is present. Perch Lake is connected to the Ottawa River via Perch Creek.

Figure 2-1 illustrates the Perch Creek catchment areas provided by the 2005 Lidar topography (Arcadis and Quintessa 2019). Most of the NSDF site lies within this catchment area.

Thorough descriptions of the CRL and NSDF site hydrology, geology, hydrogeology, climate, and ecology are provided in Section 3.1 - Site Characteristics of the PostSA Report (Arcadis and Quintessa 2019).

Figure 2-1 Perch Creek Catchment Areas Provided by 2005 Lidar Topography (Arcadis and Quintessa 2019)



2.2 Receptor Selection and Characterization

2.2.1 Receptor Selection

The Environmental Impact Statement (EIS) that was completed for the NSDF Project identified Valued Components (VCs) for the site (see EIS Section 5, CNL 2019). The ecological receptors selected for inclusion in this EcoRA were chosen based on the EIS's VCs, as well as selection criteria outlined in the CSA N288.6-12 standard (CSA 2012). The N288.6-12 selection criteria are described below:

(1) **Represents a major plant or animal group –** including at least one receptor from each of the following groups:

- (a) Aquatic and terrestrial plant species;
- (b) Small and large mammals;
- (c) Bird species with terrestrial and aquatic habitats;
- (d) Soil and benthic invertebrates;
- (e) Amphibians or reptiles;
- (f) Zooplankton; and,
- (g) Fish.

(2) **Receptor of interest to facility –** the candidate receptor can be of interest to the facility because of its use in previous monitoring studies (e.g., whitefish) or of concern for other reasons (e.g., white-tailed deer can be of interest because their high numbers have impacts on site revegetation efforts, and because they are involved in numerous vehicle collisions).

(3) **Identified by a stakeholder –** this criterion encourages selection of receptors that are of interest to stakeholders.

(4) **Potential to conduct a population effects study –** this criterion relies on a sensitive yet sufficiently robust population available to undertake a reliable survey which is able to distinguish facility-related effects from natural fluctuations and from the effects of other confounding factors.

(5) **Potential for detectable exposure to a contaminant or physical stressor –** the receptor is potentially exposed to a contaminant or physical stressor of potential concern and the exposure can likely be quantified by measurement (e.g., a contaminant likely to accumulate in tissues to a detectable level).

(6) **Potential for significant exposure to a contaminant or physical stressor –** the receptor is potentially exposed to a contaminant or physical stressor of potential concern and the exposure is potentially significant (e.g., approaching levels of concern). Organisms in the early life stages can be more likely than adults to receive significant exposure if their critical habitat is present in the exposure area.

(7) **Receptor has ecological significance –** a receptor with a well-defined and understood importance to ecosystem structure, process, or function would meet this criterion as well as a species of conservation status (e.g., a vulnerable, threatened or endangered species).

(8) **Receptor has socio-economic significance –** the receptor does not play a large ecological role but has important intrinsic or economic value to humans.

(9) **Scientific literature, a database, or other information exists on populations and stressor levels at the facility or in a reference area**.

As the NSDF study area includes portions of both terrestrial and aquatic environments, the following major biota groups were considered in the EcoRA:

- Freshwater aquatic environment:
  - Pelagic invertebrate community;
  - Benthic invertebrate community;
  - Fish (benthic and pelagic);
  - Aquatic vegetation;
  - Aquatic birds;
  - Aquatic reptiles;
  - Aquatic mammals; and,
  - Amphibians.
- Terrestrial environment:
  - Soil invertebrates;
  - Insects;
  - Terrestrial vegetation;
  - Terrestrial birds;
  - Terrestrial small and large mammals; and,
  - Terrestrial reptiles.

Table 2-1 summarizes the representative ecological receptors that were selected for inclusion in the EcoRA. These indicator species are appropriate because they reflect a variety of diets/feeding habits, cover a variety of trophic levels, are representative of the biota expected to be found in the study area, and are of interest to the facility and stakeholders. Blanding's turtle has been observed on the Chalk River Laboratories (CRL) site where the NSDF Facility will be placed. Blanding's turtle is thus an important species for the CRL site and furthermore has 'threatened' status under the *Species At Risk Act (SARA).* For these reasons a radiological assessment of Blanding's turtle was completed and included in Appendix C.

While the common watersnake, eastern milksnake, and monarch butterfly were selected for inclusion in the EcoRA, there is not sufficient information (e.g., transfer factors, exposure factors) to quantify radiological or non-radiological risks to these species. In addition, there is not sufficient information to quantify non-radiological risks to the snapping turtle. As such, these species were not evaluated quantitatively in the EcoRA; however, inferences about their exposures are made in Section 5.2.3 for the common watersnake, Section 5.2.4.2 for the eastern milksnake, Section 5.2.4.6 for the monarch butterfly, and Section 5.2.4.7 for the snapping turtle (non-radiological assessment).

Table 2-1 Ecological Receptors Selected for Inclusion

Major Biota Group	Representative Receptor	Description	Comments / SARA Status
Aquatic Environment			
Aquatic Vegetation	Reed	Tall, grass-like wetland plant	Assessed as a generic group against environmental concentrations
Pelagic Invertebrate Community	Zooplankton	Pelagic invertebrates	Assessed as a generic group against environmental concentrations
Benthic Invertebrate Community	Benthic Invertebrates	Sediment-dwelling macroinvertebrates	Assessed as a generic group against environmental concentrations
Benthic Fish	Bluntnose Minnow Black Bullhead	Benthivorous/bottom-dwelling fish	Assessed as a generic group against environmental concentrations
Pelagic Fish	Northern Pike	Pelagic predatory fish	Assessed as a generic group against environmental concentrations
Birds	Belted Kingfisher	Mainly piscivore	Assessed explicitly
	Great Blue Heron	Piscivore; large wading bird	Assessed explicitly
	Mallard	Omnivore; migrating waterfowl	Assessed explicitly
Reptiles	Snapping Turtle	Omnivore	SC; Assessed explicitly for radiological exposure and qualitatively for exposure to non-radiological contaminants
	Common Watersnake	Carnivore	Qualitative assessment
Amphibians	Green Frog	Insectivore	Assessed as a tadpole (fish)
Mammals	Moose	Herbivore	Assessed explicitly
Terrestrial Environment			
Terrestrial Vegetation	Red Maple	Upland/wetland deciduous tree	Assessed as a generic group against environmental concentrations
Soil Invertebrates	Earthworm	Soil-dwelling invertebrate	Assessed against environmental concentrations
Insects	Monarch Butterfly	Flying insect	SC; Qualitative assessment
Birds	Canada Warbler	Insectivore	THR; Assessed explicitly
	Eastern Whip-poor-will	Insectivore	THR; Assessed explicitly
	Purple Finch	Feeds on seeds/fruit	Assessed explicitly
	Ruffed Grouse	Omnivore but feeds almost exclusively on vegetation; ground-dwelling non-migratory bird	Assessed explicitly
	Bald Eagle	Piscivore/carnivore	Assessed explicitly

Major Biota Group	Representative Receptor	Description	Comments / SARA Status
Small Mammals	Little Brown Myotis	Insectivore	END; Assessed explicitly; also representing Northern Myotis (END) and Tricoloured Bat (END)
	Meadow Vole	Herbivore; soil dwelling	Assessed explicitly
	Short-tailed Shrew	Carnivore; burrowing mammal	Assessed explicitly
Large Mammals	Black Bear	Omnivore	Assessed explicitly
	Eastern Wolf	Carnivore	SC; Assessed explicitly
	White-tailed Deer	Herbivore	Assessed explicitly
Reptiles	Eastern Milksnake	Carnivore	SC; Qualitative assessment

Notes: SARA – *Species at Risk Act*; THR – threatened, END – Endangered, SC – Special Concern.

2.2.2 Species at Risk

The list of ecological receptors chosen for assessment in the EcoRA included the following species at risk, as defined under the *Species at Risk Act (SARA)*[1]:

- Canada warbler (Threatened);
- Eastern milksnake (Special Concern);
- Eastern whip-poor-will (Threatened);
- Eastern wolf (Special Concern);
- Little brown myotis (Endangered);
- Monarch butterfly (Special of Concern); and,
- Snapping turtle (Special of Concern).

2.2.3 Receptor Characterization

Ecological profiles were developed for each receptor considered in the EcoRA that was explicitly modelled. These profiles, presented in Appendix A, compile receptor-specific information related to:

- Trophic level or ecosystem role (e.g., predators or prey species);
- Size and body weight;
- Dietary composition;
- Food and water ingestion rates;

[1] The *Species at Risk Act (SARA)* defines a Species at risk as "… an extirpated, endangered or threatened species or a species of special concern. (espèce en péril)"

- Habitat;
- Habitat/home range spatial distribution and size; and,
- Time spent in the area.

It is important to understand that fish, amphibians, invertebrates, and vegetation (both aquatic and terrestrial) are assessed directly against environmental concentrations in surface water and soil with no consideration of trophic transfer. As such, pathways of exposure (e.g., ingestion, inhalation, etc.) are not explicitly modelled (or needed) for these receptors. Ecological profiles are also not required for these receptors.

2.2.4 Receptor Locations

Concentrations of radionuclides and chemical contaminants in various environmental media for use in the EcoRA were obtained from the PostSA (Arcadis and Quintessa 2019). The PostSA assumed that a residence with a backyard garden is established on top of the ECM cap (see Figure 2-2). This Garden Area represents a potential exposure area for ecological receptors. Marsh and swamp type wetlands comprise the Perch Lake Swamp area extending between the ECM and Perch Lake and Perch Creek. The PostSA assumed that animals would graze in the portion of Perch Lake Swamp that would be affected by bathtubbing during the course of normal evolution or during a permanent bathtub scenario. This area is referred to as the Grazing Area. During bathtubbing, water overtopping the ECM berm would drain to Perch Creek via the Grazing Area, resulting in wetter or flooded conditions and increased contamination of surface soil in the Grazing Area.

The post-closure phase of the NSDF Project will impact both the aquatic and terrestrial environments. In the EcoRA, receptors were assumed to be present in the following locations on and around the NSDF site (see Figure 2-2) that will potentially be impacted by post-closure activities:

- Garden Area on top of the ECM;
- Grazing Area in the Perch Lake Swamp situated between the ECM and Perch Creek;
- Perch Creek; and,
- Ottawa River near the NSDF site.

As seen from Table 2-2, aquatic biota (i.e., zooplankton, benthic invertebrates, aquatic plants, fish (both benthic and pelagic) and frogs) were assumed to be present in both close-by waterbodies, Perch Creek and Ottawa River. Soil invertebrates (e.g., earthworms) and terrestrial vegetation were assumed to be present in soil at both the Garden and Grazing Areas.

Table 2-3 breaks down the environmental media associated with each exposure area and summarizes the aquatic and terrestrial based birds and mammals that are assumed to be present in each area. The numbers in the parentheses indicate receptors that are assessed in more than one location (e.g., one (1) mallard is placed on Perch Creek and a second (2) mallard on the Ottawa River). The percentages in the square brackets indicate the fraction of the exposure obtained from that source (e.g., 50% of exposure to soil from the Garden Area and 50% from the Grazing Area for receptors with larger home ranges).

Figure 2-2 Site Map Showing Receptor Exposure Areas

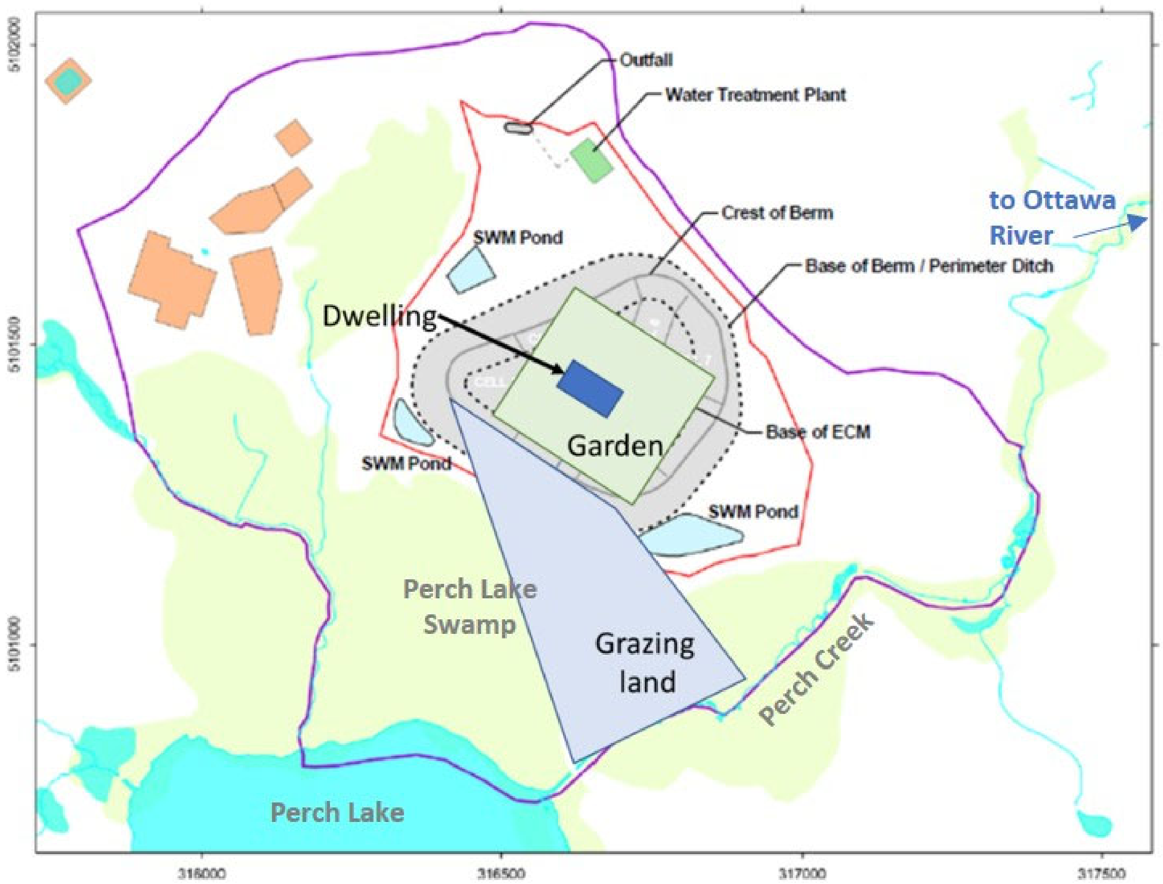


Table 2-2 Locations of Aquatic and Terrestrial Receptors Assessed Against Environmental Concentrations

Major Biota Group	Representative Receptor	Ottawa River	Perch Creek	Grazing Area between ECM and Perch Creek	Garden on ECM
Aquatic Receptors					
Pelagic Invertebrate Community	Zooplankton	√	√		
Benthic Invertebrate Community	Benthic Invertebrates	√	√		
Aquatic Vegetation	Reed	√	√		
Benthic Fish	Bluntnose Minnow, Brown Bullhead	√	√		
Pelagic Fish	Northern Pike	√	√		
Amphibians	Green Frog (tadpole)	√	√		
Terrestrial Receptors					
Soil Invertebrates	Earthworm (exposed to soil)			√	√
Terrestrial Vegetation	Red Maple			√	√

In selecting locations where aquatic and terrestrial based birds and mammals were assumed to be present (see Table 2-3), factors that were taken into consideration included not only dietary characteristics, but also the home range of the species and locations where the species would likely receive a range of exposures to the constituents of potential concern (COPCs).

Species with smaller home ranges were assumed to be present at more than one location across the site to assess exposure from different aquatic or terrestrial sources. For instance, in one case [receptor (1)] the belted kingfisher, mallard, and great blue heron were assumed to obtain 100% of their water ingestion from Perch Creek and in a second case [receptor (2)] from the Ottawa River. The Canada warbler, purple finch, ruffed grouse, meadow vole, and short-tailed shrew were assumed in one case [receptor (1)] to obtain 100% of their exposure to soil and other terrestrial media from the Garden Area and in a second case [receptor (2)] from the Grazing Area.

Species with larger home ranges such as the eastern whip-poor-will, bald eagle, white-tailed deer, moose, eastern wolf, and black bear were assumed to roam the entire site and to obtain their exposures from different areas across the site. As such, exposure to aquatic sources was split between Perch Creek and the Ottawa River and exposure to terrestrial sources was split between the Garden Area and Grazing Area.

Table 2-3 Locations of Aquatic and Terrestrial Based Birds and Mammals and Exposure Assumptions

Location and Environmental Medium	Belted Kingfisher	Mallard	Great Blue Heron	Snapping Turtle	Canada Warbler	Purple Finch	Ruffed Grouse	Meadow Vole	Short-tailed Shrew	Eastern Whip-poor-will	Bald Eagle	Little Brown Myotis	White-tailed Deer	Eastern Wolf	Black Bear	Moose
	Assessing Aquatic Sources				Assessing Terrestrial Sources					Assessed Sitewide						
AQUATIC ENVIRONMENT																
Ottawa River near NSDF Site																
Surface Water	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]						√ [50%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]
Sediment	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]												√ [50%]
Aquatic Vegetation		√ (1) [100%]		√ (1) [100%]												√ [50%]
Benthic Invertebrates & Insects		√ (1) [100%]	√ (1) [100%]									√ [50%]				
Fish (Pelagic or Benthic)	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]							√ [50%]					
Perch Creek																
Surface Water	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]	√ (1)(2) [100%]	√ (1)(2) [100%]	√ (1)(2) [100%]	√ (1)(2) [100%]	√ (1)(2) [100%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]	√ [50%]
Sediment	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]												√ [50%]
Aquatic Vegetation		√ (2) [100%]		√ (2) [100%]												√ [50%]
Benthic Invertebrates & Insects		√ (2) [100%]	√ (2) [100%]									√ [50%]				
Fish (Pelagic or Benthic)	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]							√ [50%]					
TERRESTRIAL ENVIRONMENT																
Grazing Area between ECM and Perch Creek																
Surface Water																
Soil						√ (1) [100%]	√ (1) [100%]	√ (1) [100%]	√ (1) [100%]		√ [50%]		√ [50%]	√ [50%]	√ [50%]	
Terrestrial Invertebrates & Insects		√ (1)(2) [100%]			√ (1) [100%]		√ (1) [100%]		√ (1) [100%]	√ [50%]		√ [50%]				
Terrestrial Vegetation		√ (1)(2) [100%]					√ (1) [100%]	√ (1) [100%]					√ [50%]		√ [50%]	√ [50%]
Seeds/Fruit						√ (1) [100%]										
Small Mammals (Vole, Shrew)			√ (1)(2) [100%]								√ [50%]			√ [50%]	√ [50%]	
Birds (Warbler, Whip-poor-will, Finch)											√ [50%]					
Garden on ECM																
Soil						√ (2) [100%]	√ (2) [100%]	√ (2) [100%]	√ (2) [100%]		√ [50%]		√ [50%]	√ [50%]	√ [50%]	
Terrestrial Invertebrates & Insects					√ (2) [100%]		√ (2) [100%]		√ (2) [100%]	√ [50%]		√ [50%]				
Terrestrial Vegetation							√ (2) [100%]	√ (2) [100%]					√ [50%]		√ [50%]	√ [50%]
Seeds/Fruit						√ (2) [100%]										
Small Mammals (Vole, Shrew)											√ [50%]			√ [50%]	√ [50%]	
Birds (Warbler, Whip-poor-will, Finch)											√ [50%]					
Sitewide																
White-tailed deer														√ [100%]		

Notes:

** The monarch butterfly, common watersnake, and eastern milksnake were assessed qualitatively as well as the snapping turtle for non-radiological exposure.*

(1) - indicates that the receptor is assessed in more than one location.

[50%] – indicates the percentage of the exposure (e.g., water ingestion) that is obtained from that location (e.g., Perch Creek).

2.3 Assessment and Measurement Endpoints

Assessment Endpoints

Indicator species are assessed using "assessment endpoints", which are expressions of the actual environmental values to be protected. N288.6-12 (CSA 2012) defines assessment endpoints as "…explicit expressions of the environmental values (features and functions) that environmental managers wish to protect". In general, the assessment endpoints selected in this study were healthy populations of the identified indicator species within the study area. Species at risk were considered at an individual level.

Measurement Endpoints

Typically, assessment endpoints (such as those outlined above) are qualitative in nature and do not lend themselves to direct measurement or quantification. Therefore, measurement endpoints are outlined, which are measurable or predictable expressions of the assessment endpoint. The values of measurement endpoints are dependent not only upon the species being protected, but also upon the level of protection provided. For example, a measurement endpoint suitable for ensuring reproductive success of a population may not be adequate to ensure the protection of each member of the population. Consistent with N288.6-12 (CSA 2012), measurement endpoints were based on survival, growth, and reproduction in order to more closely link the endpoints with population success.

In this study, measurement endpoints were represented by the screening index (SI): the ratio of an estimated dose rate divided by a corresponding benchmark. The SI measurement endpoint is at the population level. As a result, when the chosen benchmark encompasses long-term effects based on survival (mortality), growth, or reproduction, then the measurement endpoint is closely linked to the assessment endpoint (healthy populations) and the necessary inferences can be made (i.e., one can infer the 'healthiness' of the population). So, where an estimated exposure level is less than the corresponding benchmark (i.e., SI less than 1), effects on a population of biota are not expected; however, where an estimated exposure level is greater than the corresponding benchmark (i.e., SI greater than 1), deleterious effects on the biota population may or may not occur and further study may be required to determine potential effects. The assessment of species at risk is different in that these species are assessed at the individual rather than the population level. The SI is calculated in the same way but the benchmarks are adjusted to be protective at the individual level. For instance, for terrestrial wildlife, the No Observed Adverse Effect Level (NOAEL) toxicity reference value for chemical contaminants was used rather than the Lowest Observed Adverse Effect Level (LOAEL) toxicity reference value. If a NOAEL was not available and for radiological contaminants, the LOAEL and radiological benchmarks were adjusted to be protective at the individual level by applying a safety factor of 10.

2.4 Selection of Radiological & Non-radiological Constituents of Potential Concern

2.4.1 Background Concentrations

Available background data for radiological and non-radiological contaminants at the NSDF site are summarized in Table 2-4 and Table 2-5, respectively. For radionuclides, background data measured in

Perch Creek at the Weir (PCW) and at the CRL downstream boundary in the Ottawa River were used where available. Concentrations in soil and for additional radionuclides where based on the upper-limit background values calculated in the *CRL Environmental Backgrounds, Limits and Benchmarks Report* (CNL 2017a).

Table 2-4 Summary of Available Background Radionuclide Concentrations in Environmental Media

Radionuclide	Surface Water		Sediment		Soil
	Perch Creek	Ottawa River	Perch Creek	Ottawa River	On-site
	Bq/L(1)	Bq/L(2)	Bq/kg(3)	Bq/kg(4)	Bq/kg(5)
Tritium	3255	41	243	NA	NA
Co-60	0.01	NA	124	0.34	NA
Cs-137	0.008	0.00156	63.4	25.7	23.8
Sr-90	NA	NA	845	NA	NA
Radionuclide	**On-site**	**Ottawa River**	**On-site**	**Ottawa River**	**On-site**
	Bq/L(5)	**Bq/L(5)**	**Bq/kg dw(5)**	**Bq/kg dw(5)**	**Bq/kg dw(5)**
Ag108m	-	0.01	-		-
Am241	-	0.02	-	2.7	0.4
C14	0.25	-	50 *	-	-
Co60	0.5	0.01	-	1.08	0.0
Cs137	0.5	0.01	61	2.24	23.8
HTO	47.4	97.23	-	-	-
Pb210	-	-	-	-	196.2
Po210	-	-			30
Ra226	-	0.01	48.5	-	24.4
Ra228	-	-			12.2
Sr90	-	0.132	-	-	-
Th228	-	0.04	15	-	60
Th230	-	-	-	-	30
Th232	-	-	-	-	80
U235	-	0.15	1.3	-	0.88
U238	-	0.14	26.7	-	18.5

Notes:
* Units of Bq/kg-C dw for C-14.
NA – background data were not available from any of the sources that were reviewed.
(1) Mean of 2011-2018 concentrations measured in Perch Creek at the Weir (PCW) (Table 5.7.4-8 CNL 2019).
(2) Mean of 2011-2018 concentrations measured at Pointe au Baptême at the CRL downstream boundary for tritium and Harrington Bay for Cs-137 (Table 5.7.4-9 CNL 2019).
(3) Sediment data were not available for Perch Creek so the lower range of data for Perch Lake reported in Section 5.7.4.8 of CNL (2019) were used and for tritium the porewater concentration measured at Station #3 in 2013 was converted to a solids concentration (Table 5.7.4-12 CNL 2019).
(4) Mean concentrations for the period 2011-2018 measured at the CRL property boundary (Table 5.7.4-13 CNL 2019).
(5) Upper-limit background value (CNL 2017a).

Canadian Nuclear Laboratories (CNL). 2019. Near Surface Disposal Facility Environmental Impact Statement.
Canadian Nuclear Laboratories (CNL). 2017a. Environmental Backgrounds, Limits and Benchmarks for Monitoring Program Design, Risk Assessment and Risk Management Decisions – Chalk River Laboratories. ENVP-509220-REOT-002, Revision 0. February 2017.

For non-radionuclides, background data measured in Perch Creek at PCW were used for on-site surface water and data measured at the CRL downstream boundary for the Ottawa River. Contaminant concentrations measured in non-impacted soils across the CRL site encompassing five different surficial geology regions were used for on-site soil data. With respect to sediments, data are not available for Perch Creek and thus the lower range of data from Perch Lake were used for on-site sediments. Sediment data collected from the Ottawa River upstream/downstream of the CRL site were used for the Ottawa River; however, aluminum data were not available and the background aluminum concentration used for Perch Creek was also applied to the Ottawa River.

Table 2-5 Summary of Background Non-Radionuclide Concentrations in Environmental Media

COPC	Surface Water	Surface Water	Soil	Sediment	Sediment
	Perch Creek	Ottawa River	Grazing & Garden Areas	Perch Creek	Ottawa River
	µg/L(1)	µg/L(2)	mg/kg(3)	mg/kg dw(4)	mg/kg dw(5)
Aluminum	207	209	30,000(6)	42	42(5)
Copper	4.2	3.0	22	15	20
Lead	8	3.0	52	60	10
Uranium	0.06	0	1.5	1.0	1.3

Notes:
(1) Mean of 2012-2017 concentrations measured in Perch Creek at the Weir (PCW) (Table 6-9 CNL 2018a; Table 5-3 CNL 2018b).
(2) For aluminum and uranium: mean of 2011-2016 total (unfiltered) concentrations measured at the Otto Holden Dam station (ID 18000036002) upstream of the CRL site (OMOECC 2018) – blank subtracted uranium concentrations were reported as negative values and are reported as 0 in Table 2-5; for copper and lead: mean of 2002-2003 upper range concentrations measured at the CRL downstream boundary (Perch Creek Outfall and Pointe au Baptême) (Table 2.5.4.2 Surface Water Modelling Data, CNL 2017b).
(3) For non-radionuclides: mean of concentrations measured in 40 samples collected in 2016 from non-impacted areas across the CRL site encompassing five different surficial geology regions (Table 2, Silke and Clemow 2018).
(4) For non-radionuclides: no sediment data were available for Perch Creek so data from June 2018 from Perch Lake Station #3 were used, which had the lowest contaminant concentrations measured in Perch Lake and is located near the outlet to Perch Creek (Table 6-1, CNL 2018b).
(5) For non-radionuclides: mean concentrations of 16 shallow sediment samples collected in the fall of 2016 from the Ottawa River, upstream/downstream of the CNL NPD site (Golder 2017); sediment data were not available for aluminum and the baseline concentration was assumed to be the same as for Perch Creek, 42 mg/kg dw.
(6) Table 8.3: Soil – Rural Parks, OTR_{98}, Ontario Typical Range value representing the 97.5th percentile distribution of a database of surface soils in Ontario that are not contaminated by point sources (OMOE 2011a).

Canadian Nuclear Laboratories (CNL). 2018a. Annual Safety Report. Environmental Monitoring in 2017 at Chalk River Laboratories. CRL-509243-ASR-2017, Revision 0. June 15, 2018.
Canadian Nuclear Laboratories (CNL). 2018b. Characterization of Water and Sediments from and around Perch Lake, Near Surface Disposal Facility, 232-121221-REPT-002, Revision 0, September 28, 2018.
Canadian Nuclear Laboratories (CNL). 2017b. Near Surface Disposal Area Environmental Impact Statement, Revision 0, March 2017.
Golder Associates Limited (Golder). 2017. RFI 007 - Conventional Contaminants of Concern (CCOC) Analysis for Class 3 and BRA. April 2017. CNL File No. 64-509410-REPT-003, Rev. 0.
Ontario Ministry of the Environment (OMOE). 2011a. Rationale for the Development of Soil and Groundwater Standards for Use at Contaminated Sites in Ontario. Standards Development Branch. PIBS 7386e01. 15 April.
Ontario Ministry of the Environment and Climate Change (OMOECC). 2018. Provincial (Stream) Water Quality Monitoring Network. https://www.ontario.ca/data/provincial-stream-water-quality-monitoring-network. Accessed in November 2018.
Silke, R. and S. Clemow. 2018. Background Concentrations of Metals at the CRL Site. Memo to M. Klukas dated April 12, 2018. CNL File No. 182-509895-021-000.

2.4.2 Radiological Constituents of Concern

2.4.2.1 Screening Procedure

For each scenario assessed, the PostSA (Arcadis and Quintessa 2019) predicted radionuclide concentrations over time (i.e., 10,000-year assessment timeframe) in all relevant environmental media (i.e., surface water and sediment in Perch Creek and Ottawa River and soil in Grazing Area and Garden Area). Environmental concentrations were predicted for the following radionuclides:

- Ac-227
- Ag-108m
- Am-241
- Am-243
- C-14
- Cl-36
- Co-60
- Cs-135
- Cs-137
- Cu-29
- H-3
- I-129
- Mo-93
- Nb-93m
- Nb-94
- Ni-59
- Ni-63
- Np-237
- Pa-231
- Pb-210
- Po-210
- Pu-239
- Pu-241
- Pu-242
- Ra-226
- Ra-228
- Sr-90
- Tc-99
- Th-228
- Th-229
- Th-230
- Th-232
- U-233
- U-234
- U-235
- U-238

For the COPC screening process, maximum radionuclide concentrations predicted over the 10,000-year assessment period in each environmental medium were screened against site-specific Environmental Effect Concentration (EEC) values developed for the CRL site (EcoMetrix and AECL 2012). The EECs were derived based on a screening dose of 100 µGy/h (2.4 mGy/d) for terrestrial organisms (soil EECs) and 400 µGy/h (9.6 mGy/h) for aquatic organisms (water and sediment EECs), consistent with UNSCEAR (2008). However, the EEC set for radionuclides is very limited and thus Environmental Media Concentrations (EMCs) from the ERICA Assessment Tool (ERICA 2019) were used to infill missing values. The EMCs were derived based on a screening dose of 10 µGy/h (0.24 mGy/d) for all ecosystems and were adjusted to be consistent with UNSCEAR (2008) by multiplying by a factor of 10 for terrestrial organisms (soil EMCs) and a factor of 40 for aquatic organisms (water and sediment EMCs). In addition, two No-Effect Concentrations (NECs) from SENES (2008) were used to screen C-14 and Cl-36 concentrations in soil. These NECs were derived based on a screening dose of 42 µGy/h (1 mGy/d) for terrestrial organisms and were adjusted to be consistent with UNSCEAR (2008) by multiplying by a factor of 2.4. Thus, all of the radiological environmental screening criteria used in this assessment are consistent with screening dose rates from UNSCEAR (2008). The environmental screening criteria are included in Table 2-9 to Table 2-27, which summarize the maximum radionuclide environmental concentrations predicted for each scenario and the COPC screening results.

If the maximum incremental radionuclide concentration was below the environmental screening criterion for all environmental media associated with a particular scenario, then the radionuclide was ‘screened-out’ and excluded from assessment in the EcoRA for that scenario (Outcome 1). A radionuclide would also be ‘screened-out’ if a dose coefficient was not available (Outcome 2). This was the case for Ag-108m, Am-243 and Cu-29. While it is noted that excluding a radionuclide from would result in an underestimation of the total dose and associated effects, the radiation dose cannot be estimated without a dose coefficient.

If the maximum incremental concentration of a radionuclide exceeded the environmental screening criterion in at least one environmental medium associated with a particular scenario, and a dose coefficient was available for that radionuclide, then the radionuclide was 'screened-in' for assessment for that scenario (Outcome 3). Also, if an environmental screening criterion was not available for a particular radionuclide, but a dose coefficient was available, then the radionuclide was automatically 'screened-in' for assessment (Outcome 4). This was the case for Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233 and Zr-93 in all scenarios. If neither an environmental screening criterion nor a dose coefficient was available, then the radionuclide was 'screened-out' (Outcome 5).

The procedure to select radiological COPCs for inclusion in the EcoRA is outlined below in Table 2-6. The first column lists the sequence of criteria that are considered in arriving at the screening decision shown in the final row of the table. The subsequent columns summarize the possible screening outcomes for each radionuclide based on the responses to each screening criterion. This screening approach is consistent with N288.6-12 (CSA 2012).

Table 2-6 Screening Procedure for the Selection of Radiological COPCs for Inclusion in the EcoRA

Screening Criteria	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
Environmental Screening Criterion Available?	Yes	Yes	Yes	No	No
Concentration > Environmental Screening Criterion	No	Yes	Yes	-	-
Dose Coefficient Available?	-	No	Yes	Yes	No
Screening Decision	Screen Out	Screen Out	Screen In	Screen In	Screen Out

As discussed in Section 2.4.2.2, most of the radionuclides listed above were 'screened-out' of the assessment due to predicted concentrations being below environmental screening criteria. While concentrations were below screening criteria, there is still a possibility of a potential effect because the sum of a large number of low concentrations that individually do not cause an effect, could still be of sufficient cumulative value to pose a risk. In order to assess this possibility, a sum of fractions approach was used following U.S. Department of Energy (U.S. DOE 2019) methodology. For each environmental medium associated with each scenario, the concentration of each radionuclide was divided by the corresponding environmental screening criterion and the fractions were summed for that medium. The sum of fractions were then summed across environmental media for aquatic (Perch Creek and Ottawa River) and terrestrial (Grazing Area and Garden Area) system (see Table 2-7). The sum of fractions were also summed across all media as 'sitewide' receptors are exposed through all of the aquatic and terrestrial systems obtaining half exposure to aquatic sources from Perch Creek or Ottawa River and half exposure to terrestrial sources from the Garden Area or Grazing Area. A sum of fractions value of < 1 indicates no significant ecological impact and a value ≥ 1 requires further assessment. The sum of fractions results are summarized in Table 2-7 for each aquatic and terrestrial system for each scenario. As seen from Table 2-7, a value > 1 was obtained for aquatic and terrestrial systems associated with scenarios (1a), (1c) and (15). Specifically, for Perch Creek, the Garden Area and Grazing Area for scenario (1a); Perch Creek and the Grazing Area for scenario (1c); and Perch Creek, the Garden Area and Grazing Area for scenario (15). For these aquatic and terrestrial systems, the top five radionuclides contributing to the sum of fractions in each associated medium (e.g., Perch Creek water and sediment; Perch Creek water and Garden Area soil) were identified and assessed in the EcoRA for the corresponding scenario. These radionuclides are shown in Table 2-8. The sum of the remaining fractions for each aquatic or terrestrial system was < 0.35.

Table 2-7 Sum of Fractions Analysis for Aquatic and Terrestrial

Scenario	Sum of Fractions – For Environmental Media						Sum of Fractions – For Aquatic and Terrestrial Systems				
	Perch Creek	Perch Creek	Ottawa River	Ottawa River	Garden Area	Grazing Area	Aquatic System	Aquatic System	Terrestrial System	Terrestrial System	Aquatic + Terrestrial Systems (for Sitewide Receptors)
	Surface Water (SW)	Sediment (Sed)	Surface Water (SW)	Sediment (Sed)	Soil	Soil	Perch Creek (SW + Sed)	Ottawa River (SW + Sed)	Garden Area (Soil) + Perch Creek (SW)	Grazing Area (Soil) + Perch Creek (Water)	50% Perch Creek (SW + Sed) + 50% Ottawa River (SW + Sed) + 50% Grazing Area (Soil) + 50% Garden Area (Soil)
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization – Confidence in Land Use Restrictions	0.09	0.14	0.00	0.00	0.03	0.31	0.22	0.00	0.12	0.40	0.28
(1a) NES SA - Inventory Sensitivity	0.80	**1.18**	0.00	0.00	0.30	**1.76**	**1.97**	0.00	**1.10**	**2.56**	**2.02**
(1b) NES SA - Institutional Control Sensitivity	0.09	0.14	0.00	0.00	0.03	0.31	0.22	0.00	0.12	0.40	0.28
(1c) NES SA - Sorption Coefficient Sensitivity	0.48	0.53	0.00	0.00	0.03	**1.23**	**1.01**	0.00	0.51	**1.71**	**1.14**
(1d) NES SA - Geosphere - Rapid Transit to Perch Creek	0.09	0.15	0.00	0.00	0.03	0.31	0.24	0.00	0.12	0.40	0.29
(1e) NES SA - Enhanced Degradation of Cover and Liner	0.15	0.22	0.00	0.00	0.03	0.19	0.37	0.00	0.18	0.35	0.30
(1f) NES SA - Global Warming - Reduced HER	0.05	0.13	0.00	0.00	0.03	0.26	0.19	0.00	0.08	0.31	0.24
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)	0.09	0.14	0.00	0.00	0.26	0.31	0.22	0.00	0.35	0.40	0.40
(4) Disruptive Event - Enhanced Erosion Case	0.12	0.23	0.00	0.00	0.03	0.14	0.35	0.00	0.15	0.26	0.26
(5) Disruptive Event - Localized Cover Failure	0.11	0.14	0.00	0.00	0.03	0.35	0.24	0.00	0.14	0.46	0.31
(6) Disruptive Event - Localized Liner Failure	0.07	0.17	0.00	0.00	0.03	0.24	0.24	0.00	0.10	0.32	0.26
(7) Disruptive Event - Damage to Berm	0.11	0.13	0.00	0.00	0.03	0.38	0.24	0.00	0.14	0.49	0.32
(8) Dose Optimization - Wastes Grouted into Steel Liners	0.09	0.13	0.00	0.00	0.03	0.31	0.21	0.00	0.12	0.40	0.28
(11) Defence-in-Depth - Role of Geosphere	0.12	0.46	0.00	0.00	0.03	0.31	0.58	0.00	0.15	0.43	0.46
(12) Defence-in-Depth - Role of Cover	0.40	0.34	0.00	0.00	0.03	0.43	0.73	0.00	0.43	0.83	0.60
(13) Defence-in-Depth - Role of Base Liner	0.04	0.20	0.00	0.00	0.03	0.00	0.24	0.00	0.07	0.04	0.14
(14) Defence-in-Depth - Series of Landslides	0.38	0.30	0.00	0.00	0.03	0.31	0.68	0.00	0.41	0.70	0.51
(15) What If - Human Intrusion, Mass Excavation and Farming	**2.82**	**1.72**	0.00	0.00	0.27	0.51	**4.54**	0.00	**3.09**	**3.33**	**2.66**
(17) What If - Permanent Bathtub	0.21	0.14	0.00	0.00	0.03	0.64	0.35	0.00	0.24	0.85	0.51

Table 2-8 Top Five Radionuclides Contributing Activity for Aquatic and Terrestrial Systems with Sum of Fractions > 1

Scenario	Aquatic System Perch Creek (Water + Sediment)	Terrestrial System Garden Area (Soil) + Perch Creek (Water)	Terrestrial System Grazing Area (Soil) + Perch Creek (Water)
(1a) NES SA - Inventory Sensitivity			
Top 5 Radionuclides Contributing to Sum of Fractions	Po-210, Pu-239, Cl-36, C-14, Am-241	Po-210, Pu-239, C-14, Am-241, I-129	R-226, Po-210, Th-228, Pu-239, Cl-36
Sum of Fractions for Remaining Radionuclides with Screening Criterion	0.11	0.005	0.33
(1c) NES SA - Sorption Coefficient Sensitivity			
Top 5 Radionuclides Contributing to Sum of Fractions	Po-210, C-14, Pu-239, Am-241, Cl-36	NA	Ra-226, Th-228, Po-210, Pu-239, Am-241
Sum of Fractions for Remaining Radionuclides with Screening Criterion	0.08	NA	0.18
(15) What If - Human Intrusion, Mass Excavation and Farming			
Top 5 Radionuclides Contributing to Sum of Fractions	Po-210, C-14, Am-241, Pu-239, Cl-36	Po-210, Pu-239, Am-241, Ra-226, Th-228	Po-210, Pu-239, C-14, Am-241, Th-228
Sum of Fractions for Remaining Radionuclides with Screening Criterion	0.11	0.13	0.22

Notes: NA – Not Applicable

2.4.2.2 Screening Results

For each post-closure scenario considered in the EcoRA, the maximum radionuclide concentrations predicted over the 10,000-year PostSA timeframe in surface water (Perch Creek and Ottawa River), soil (Grazing Area and Garden Area), and sediment (Perch Creek and Ottawa River) were used in the COPC screen. Using the peak concentration (regardless of the time of the peak) is conservative, as it ensures biota are assessed for the worst predicted exposure even though realistically these peaks would occur at different times (e.g., the soil peak concentration may occur at 100 years post-closure, but the creek peak concentration may occur hundreds of years later). The PostSA predicted maximum radionuclide concentrations for the following areas:

- Garden Area on top of the ECM;
- Grazing Area in the Perch Lake Swamp situated between the ECM and Perch Creek in the section adjacent to the ECM;
- Perch Creek in the upper section closest to the ECM; and,
- Ottawa River near the NSDF site at the confluence with Perch Creek.

The maximum environmental radionuclide concentrations for each scenario, along with the environmental screening criteria and the screening decision, are summarized in Table 2-9 to Table 2-27. If a radionuclide exceeded the environmental criterion in at least one environmental medium then it was 'screened-in' (i.e., assessed) for that scenario. Radionuclides selected as COPCs for assessment based on the COPC screen for each scenario and the sum of fractions analysis are summarized in Table 2-28.

Table 2-9 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenarios (1) Normal Evolution Scenario (NES) and (9) Dose Optimization - Confidence in Land Use Restrictions

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(1) Normal Evolution Scenario and (9) Dose Optimization - Confidence in Land Use Restrictions														
Ac227	1.87E-05	2.45E-08	0.00E+00	1.56E-02	1.07E-02	3.89E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.77E-06	6.25E-09	0.00E+00	2.09E-01	6.53E-01	3.75E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.54E-03	3.33E-06	0.00E+00	5.70E+00	4.67E+01	2.39E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.43E-06	3.19E-09	0.00E+00	2.41E-02	4.69E-02	2.75E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.18E-02	1.06E-04	1.70E+01	1.70E+00	1.52E+02	4.95E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-03	8.13E-06	0.00E+00	2.63E-02	3.70E+00	9.85E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	0.00E+00	9.96E-23	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.77E-06	8.87E-09	0.00E+00	3.71E-01	5.45E-01	8.08E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.50E-11	5.89E-14	0.00E+00	4.86E-04	1.40E-07	9.73E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.45E-05	3.20E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.45E-02	4.52E-05	0.00E+00	2.41E+01	3.35E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.85E-08	5.04E-11	0.00E+00	3.57E-04	7.90E-05	3.89E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.86E-04	7.68E-07	0.00E+00	5.71E+02	9.85E+00	1.64E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	3.53E-05	4.62E-08	0.00E+00	2.98E+01	8.03E-01	7.80E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.67E-05	2.18E-08	0.00E+00	2.89E-01	1.67E-01	2.78E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.49E-06	9.81E-09	0.00E+00	4.18E-01	3.49E-03	5.00E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-05	4.63E-08	0.00E+00	2.54E-04	6.70E-04	1.01E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.25E-06	1.21E-08	0.00E+00	4.22E-02	7.89E-02	4.44E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	9.74E-05	1.28E-07	0.00E+00	1.38E+01	5.40E-02	1.07E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	2.62E-03	3.39E-06	0.00E+00	1.26E+01	1.06E-01	1.07E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-02	2.86E-05	0.00E+00	2.42E+01	9.91E+02	4.54E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	9.11E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-05	2.09E-08	0.00E+00	1.83E-02	7.25E-01	3.34E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.37E-05	1.79E-08	0.00E+00	1.54E+01	1.10E+00	1.23E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	6.06E-06	7.93E-09	0.00E+00	4.73E+01	6.84E-02	6.65E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.36E-08	4.40E-11	0.00E+00	1.39E-03	2.32E-05	1.31E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	2.89E-07	3.83E-10	0.00E+00	4.73E+01	6.86E-02	6.66E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.97E-09	1.31E-11	0.00E+00	8.33E-02	1.43E-02	2.40E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.15E-07	5.43E-10	0.00E+00	1.16E+01	5.16E-01	1.00E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	2.86E-07	3.75E-10	0.00E+00	4.76E+01	7.05E-02	6.70E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.74E-06	8.83E-09	0.00E+00	1.02E-01	9.36E-03	4.32E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.78E-03	2.33E-06	0.00E+00	2.50E+01	2.47E+00	1.14E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.62E-05	9.99E-08	0.00E+00	1.08E+00	1.06E-01	4.89E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.97E-03	2.57E-06	0.00E+00	2.72E+01	2.74E+00	1.25E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.36E-03	1.78E-06	0.00E+00	5.70E+02	3.59E+01	1.71E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-10 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (1a) NES Sensitivity Analysis – Inventory Sensitivity

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(1a) NES Sensitivity Analysis - Inventory Sensitivity														
Ac227	7.75E-05	1.01E-07	0.00E+00	1.52E-01	3.10E-02	1.18E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.77E-05	6.25E-08	0.00E+00	2.09E+00	6.53E+00	3.75E-03	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.54E-02	3.33E-05	0.00E+00	5.70E+01	4.67E+02	2.39E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.43E-05	3.19E-08	0.00E+00	2.41E-01	4.69E-01	2.75E-05	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.18E-01	1.06E-03	1.70E+02	1.70E+01	1.52E+03	4.95E-02	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-02	8.13E-05	0.00E+00	2.63E-01	3.70E+01	9.85E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-28	9.14E-31	0.00E+00	1.09E-21	4.02E-22	1.20E-27	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.77E-05	8.87E-08	0.00E+00	3.71E+00	5.45E+00	8.08E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.50E-10	5.89E-13	0.00E+00	4.86E-03	1.40E-06	9.73E-10	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.45E-05	3.20E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-01	5.51E-04	6.34E+00	4.22E+00	1.60E+00	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.45E-01	4.52E-04	0.00E+00	2.41E+02	3.35E+04	1.21E+00	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.85E-07	5.04E-10	0.00E+00	3.57E-03	7.90E-04	3.89E-08	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.86E-03	7.68E-06	0.00E+00	5.71E+03	9.85E+01	1.64E-02	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	3.53E-04	4.62E-07	0.00E+00	2.98E+02	8.03E+00	7.80E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.67E-04	2.18E-07	0.00E+00	2.89E+00	1.67E+00	2.78E-04	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.49E-05	9.81E-08	0.00E+00	4.18E+00	3.49E-02	5.00E-05	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-04	4.63E-07	0.00E+00	2.54E-03	6.70E-03	1.01E-06	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.24E-05	1.21E-07	0.00E+00	3.64E-01	2.27E-01	1.35E-05	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	8.43E-04	1.10E-06	0.00E+00	1.34E+02	2.19E-01	8.93E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	2.30E-02	2.98E-05	0.00E+00	1.22E+02	4.39E-01	8.92E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-01	2.86E-04	0.00E+00	2.42E+02	9.91E+03	4.54E-01	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-09	6.43E-12	0.00E+00	9.12E-09	2.84E-04	8.02E-10	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-04	2.09E-07	0.00E+00	1.83E-01	7.25E+00	3.34E-04	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.14E-04	1.50E-07	0.00E+00	1.48E+02	4.39E+00	1.02E-03	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	1.12E-05	1.47E-08	0.00E+00	1.47E+02	1.29E-01	1.24E-04	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.36E-07	4.40E-10	0.00E+00	1.39E-02	2.32E-04	1.31E-08	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	2.99E+00	3.92E-03	0.00E+00	2.54E+01	3.89E+02	1.52E-02	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	5.36E-07	7.10E-10	0.00E+00	1.47E+02	1.29E-01	1.24E-04	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	2.07E-08	2.71E-11	0.00E+00	2.57E-01	2.96E-02	4.98E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	8.65E-07	1.13E-09	0.00E+00	3.57E+01	1.09E+00	2.09E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	5.31E-07	6.95E-10	0.00E+00	1.47E+02	1.32E-01	1.25E-04	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	1.43E-05	1.87E-08	0.00E+00	2.06E-01	1.95E-02	9.26E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	3.84E-03	5.03E-06	0.00E+00	5.07E+01	5.30E+00	2.50E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	1.64E-04	2.15E-07	0.00E+00	2.19E+00	2.26E-01	1.07E-05	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	4.01E-03	5.26E-06	0.00E+00	5.52E+01	5.73E+00	2.59E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.36E-02	1.78E-05	0.00E+00	5.70E+03	3.59E+02	1.71E-02	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:
N/A - screening criterion not available
DCC - dose conversion coefficient

[Blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Orange] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.
United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-11 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (1b) NES Sensitivity Analysis – Institutional Control Sensitivity

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity														
Ac227	1.87E-05	2.45E-08	0.00E+00	1.56E-02	1.07E-02	3.89E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.77E-06	6.25E-09	0.00E+00	2.09E-01	6.53E-01	3.75E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.54E-03	3.33E-06	0.00E+00	5.70E+00	4.67E+01	2.39E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.43E-06	3.19E-09	0.00E+00	2.41E-02	4.69E-02	2.75E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.18E-02	1.06E-04	1.70E+01	1.70E+00	1.52E+02	4.95E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-03	8.13E-06	0.00E+00	2.63E-02	3.70E+00	9.85E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	0.00E+00	9.96E-23	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.77E-06	8.87E-09	0.00E+00	3.71E-01	5.45E-01	8.08E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.50E-11	5.89E-14	0.00E+00	4.86E-04	1.40E-07	9.73E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.45E-05	3.20E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.45E-02	4.52E-05	0.00E+00	2.41E+01	3.35E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.85E-08	5.04E-11	0.00E+00	3.57E-04	7.90E-05	3.89E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.86E-04	7.68E-07	0.00E+00	5.71E+02	9.85E+00	1.64E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	3.53E-05	4.62E-08	0.00E+00	2.98E+01	8.03E-01	7.80E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.67E-05	2.18E-08	0.00E+00	2.89E-01	1.67E-01	2.78E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.49E-06	9.81E-09	0.00E+00	4.18E-01	3.49E-03	5.00E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-05	4.63E-08	0.00E+00	2.54E-04	6.70E-04	1.01E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.25E-06	1.21E-08	0.00E+00	4.22E-02	7.89E-02	4.44E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	9.74E-05	1.28E-07	0.00E+00	1.38E+01	5.40E-02	1.07E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	2.62E-03	3.39E-06	0.00E+00	1.26E+01	1.06E-01	1.07E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-02	2.86E-05	0.00E+00	2.42E+01	9.91E+02	4.54E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	9.11E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-05	2.09E-08	0.00E+00	1.83E-02	7.25E-01	3.34E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.37E-05	1.79E-08	0.00E+00	1.54E+01	1.10E+00	1.23E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	6.06E-06	7.93E-09	0.00E+00	4.73E+01	6.84E-02	6.65E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.36E-08	4.40E-11	0.00E+00	1.39E-03	2.32E-05	1.31E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	2.89E-07	3.83E-10	0.00E+00	4.73E+01	6.86E-02	6.66E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.97E-09	1.31E-11	0.00E+00	8.33E-02	1.43E-02	2.40E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.15E-07	5.43E-10	0.00E+00	1.16E+01	5.16E-01	1.00E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	2.86E-07	3.75E-10	0.00E+00	4.76E+01	7.05E-02	6.70E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.74E-06	8.83E-09	0.00E+00	1.02E-01	9.36E-03	4.32E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.78E-03	2.33E-06	0.00E+00	2.50E+01	2.47E+00	1.14E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.62E-05	9.99E-08	0.00E+00	1.08E+00	1.06E-01	4.89E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.97E-03	2.57E-06	0.00E+00	2.72E+01	2.74E+00	1.25E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.36E-03	1.78E-06	0.00E+00	5.70E+02	3.59E+01	1.71E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue shading] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Orange shading] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green shading] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-12 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (1c) NES Sensitivity Analysis – Sorption Coefficient Sensitivity

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity														
Ac227	7.34E-05	9.61E-08	0.00E+00	8.70E-02	4.13E-02	1.41E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.62E-05	6.05E-08	0.00E+00	2.04E+00	6.22E+00	3.61E-03	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.40E-02	3.14E-05	0.00E+00	1.17E+01	9.53E+02	3.54E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.30E-05	3.01E-08	0.00E+00	4.23E-02	9.12E-01	4.10E-05	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	4.31E-01	5.57E-04	1.70E+01	4.22E+00	8.35E+02	1.97E-02	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	8.64E-03	1.13E-05	0.00E+00	1.07E-02	7.26E+00	1.27E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.21E-25	8.13E-28	0.00E+00	1.03E-21	3.57E-19	1.07E-24	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	3.90E-05	5.10E-08	0.00E+00	2.52E+00	4.71E+00	4.39E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.26E-10	5.58E-13	0.00E+00	4.61E-03	1.31E-06	9.15E-10	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.45E-05	3.20E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-02	5.51E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	5.36E-02	7.02E-05	0.00E+00	1.41E+01	6.41E+03	1.91E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	1.08E-07	1.41E-10	0.00E+00	5.80E-04	3.87E-04	1.09E-08	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	6.22E-03	8.15E-06	0.00E+00	4.00E+03	2.39E+02	3.81E-02	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	1.88E-04	2.46E-07	0.00E+00	1.80E+02	5.70E+00	4.16E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.23E-04	1.62E-07	0.00E+00	2.27E+00	1.54E+00	1.83E-04	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	6.61E-05	8.66E-08	0.00E+00	3.75E+00	3.03E-02	4.34E-05	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	7.62E-05	9.98E-08	0.00E+00	4.89E-04	2.78E-03	1.42E-06	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	6.00E-05	7.85E-08	0.00E+00	2.36E-01	2.83E-01	1.61E-05	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	6.71E-04	8.78E-07	0.00E+00	1.10E+02	1.94E-01	7.03E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	1.90E-02	2.46E-05	0.00E+00	9.94E+01	3.81E-01	7.02E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	5.63E-02	7.37E-05	0.00E+00	3.82E+01	2.98E+03	9.03E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-08	6.42E-11	0.00E+00	9.32E-10	2.84E-03	8.01E-09	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	4.11E-05	5.38E-08	0.00E+00	2.86E-02	2.18E+00	6.62E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	8.98E-05	1.18E-07	0.00E+00	1.22E+02	3.94E+00	8.02E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	1.12E-05	1.47E-08	0.00E+00	1.47E+02	1.29E-01	1.24E-04	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	2.26E-07	2.96E-10	0.00E+00	9.52E-03	1.59E-04	8.12E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.01E-01	9.17E-04	0.00E+00	2.29E+00	1.28E+02	2.71E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	5.36E-07	7.11E-10	0.00E+00	1.47E+02	1.29E-01	1.24E-04	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	2.80E-08	3.66E-11	0.00E+00	2.37E-01	4.16E-02	6.78E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	1.10E-06	1.44E-09	0.00E+00	3.52E+01	1.47E+00	2.67E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	5.31E-07	6.95E-10	0.00E+00	1.47E+02	1.32E-01	1.25E-04	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	1.64E-05	2.15E-08	0.00E+00	2.06E-01	2.28E-02	1.06E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	4.25E-03	5.56E-06	0.00E+00	5.08E+01	5.91E+00	2.74E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	1.83E-04	2.39E-07	0.00E+00	2.19E+00	2.54E-01	1.18E-05	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	4.72E-03	6.19E-06	0.00E+00	5.52E+01	6.48E+00	3.05E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	3.16E-02	4.14E-05	0.00E+00	4.00E+03	8.66E+02	4.10E-02	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[orange] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-13 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (1d) NES Sensitivity Analysis – Geosphere - Rapid Transit to Perch Creek

Radionuclide	Perch Creek	Ottawa River	Garden Area	Grazing Area	Perch Creek	Ottawa River	Screening Criterion						Screen In?	Comment
	Surface Water	Surface Water	Soil	Soil	Sediment	Sediment	Surface Water	Surface Water	Soil	Soil	Sediment	Sediment		
	(Bq/L)	(Bq/L)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/L)	(Bq/L)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/kg)		
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek														
Ac227	1.96E-05	2.57E-08	0.00E+00	1.56E-02	1.12E-02	4.10E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.85E-06	6.35E-09	0.00E+00	2.09E-01	8.41E-01	3.84E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	3.15E-03	4.12E-06	0.00E+00	5.81E+00	6.93E+01	3.46E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	3.00E-06	3.93E-09	0.00E+00	2.42E-02	6.96E-02	3.97E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.22E-02	1.06E-04	1.70E+01	1.70E+00	1.54E+02	4.96E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.20E-03	8.12E-06	0.00E+00	2.63E-02	3.70E+00	9.86E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	1.26E-27	1.64E-30	0.00E+00	9.92E-23	7.23E-22	2.16E-27	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.98E-06	9.14E-09	0.00E+00	3.71E-01	7.35E-01	8.38E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.50E-11	5.90E-14	0.00E+00	4.86E-04	1.51E-07	9.74E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.50E-05	3.28E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.65E-02	6.08E-05	6.34E-01	4.23E-01	1.84E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.47E-02	4.55E-05	0.00E+00	2.41E+01	3.38E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	4.22E-08	5.53E-11	0.00E+00	3.57E-04	8.87E-05	4.13E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.88E-04	7.71E-07	0.00E+00	5.71E+02	9.89E+00	1.66E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	4.31E-05	5.65E-08	0.00E+00	2.98E+01	1.27E+00	9.53E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.68E-05	2.20E-08	0.00E+00	2.89E-01	2.22E-01	2.83E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.50E-06	9.83E-09	0.00E+00	4.18E-01	4.54E-03	5.01E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.58E-05	4.68E-08	0.00E+00	2.54E-04	6.72E-04	1.44E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	1.03E-05	1.35E-08	0.00E+00	4.22E-02	8.30E-02	4.67E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	1.01E-04	1.32E-07	0.00E+00	1.38E+01	6.63E-02	1.16E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	2.68E-03	3.47E-06	0.00E+00	1.26E+01	1.31E-01	1.16E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.37E-02	3.10E-05	0.00E+00	2.42E+01	1.09E+03	4.87E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	7.87E-10	1.03E-12	0.00E+00	9.11E-10	4.55E-05	1.29E-10	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.73E-05	2.27E-08	0.00E+00	1.83E-02	7.99E-01	3.57E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.49E-05	1.96E-08	0.00E+00	1.54E+01	1.34E+00	1.33E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	6.22E-06	8.15E-09	0.00E+00	4.73E+01	9.59E-02	6.94E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.50E-08	4.58E-11	0.00E+00	1.39E-03	3.69E-05	1.38E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.12E-01	9.32E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	3.06E-07	4.05E-10	0.00E+00	4.73E+01	9.58E-02	6.94E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.03E-08	1.35E-11	0.00E+00	8.33E-02	1.49E-02	2.48E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.31E-07	5.65E-10	0.00E+00	1.16E+01	5.43E-01	1.04E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	2.99E-07	3.92E-10	0.00E+00	4.76E+01	9.15E-02	6.99E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.96E-06	9.11E-09	0.00E+00	1.02E-01	9.50E-03	4.47E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.83E-03	2.40E-06	0.00E+00	2.50E+01	2.51E+00	1.18E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.85E-05	1.03E-07	0.00E+00	1.08E+00	1.08E-01	5.05E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	2.02E-03	2.65E-06	0.00E+00	2.72E+01	2.77E+00	1.30E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.33E-03	1.74E-06	0.00E+00	5.70E+02	3.54E+01	1.75E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Orange] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-14 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (1e) NES Sensitivity Analysis – Enhanced Degradation of Cover and Liner

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner												N/A		
Ac227	1.91E-05	2.50E-08	0.00E+00	3.25E-03	1.12E-02	3.90E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.33E-06	5.66E-09	0.00E+00	2.49E-01	5.93E-01	3.07E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	1.17E-02	1.53E-05	0.00E+00	1.71E+01	2.23E+02	1.07E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	1.12E-05	1.47E-08	0.00E+00	1.65E-02	2.13E-01	1.24E-05	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	2.47E-01	3.20E-04	1.70E+01	1.85E+00	3.62E+02	1.23E-02	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.85E-03	8.98E-06	0.00E+00	3.21E-02	3.93E+00	1.02E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	8.22E-29	1.08E-31	0.00E+00	6.05E-19	4.73E-23	1.42E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	3.20E-06	4.20E-09	0.00E+00	3.07E-01	6.35E-01	3.68E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	3.55E-10	4.65E-13	0.00E+00	3.86E-03	1.12E-06	7.85E-10	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	4.62E-06	6.06E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-02	5.51E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.31E-02	4.34E-05	0.00E+00	2.75E+01	3.25E+03	1.38E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.56E-08	4.66E-11	0.00E+00	3.77E-04	7.55E-05	3.66E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	2.62E-04	3.44E-07	0.00E+00	2.57E+02	7.37E+00	1.24E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	9.64E-06	1.26E-08	0.00E+00	1.73E+01	2.64E-01	2.13E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	9.98E-06	1.31E-08	0.00E+00	2.79E-01	1.01E-01	1.33E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	1.44E-05	1.89E-08	0.00E+00	9.12E-01	6.60E-03	9.09E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	5.78E-05	7.57E-08	0.00E+00	2.77E-04	1.22E-03	4.42E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	3.01E-05	3.94E-08	0.00E+00	9.18E-03	8.21E-02	4.46E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	2.16E-05	2.82E-08	0.00E+00	8.72E+00	4.01E-02	5.08E-05	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	3.53E-03	4.57E-06	0.00E+00	8.16E+00	7.82E-02	5.06E-05	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	3.88E-02	5.08E-05	0.00E+00	7.59E+00	1.56E+03	6.91E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	7.83E-10	1.02E-12	0.00E+00	5.35E-08	4.51E-05	1.31E-10	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	2.83E-05	3.71E-08	0.00E+00	5.55E-03	1.14E+00	5.07E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	6.03E-06	7.90E-09	0.00E+00	9.12E+00	8.22E-01	5.87E-05	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	1.91E-06	2.50E-09	0.00E+00	1.56E+01	2.28E-02	2.11E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.12E-07	4.08E-10	0.00E+00	1.26E-02	1.99E-04	1.17E-08	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	0.00E+00	3.02E+00	1.20E+02	2.51E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	9.15E-08	1.21E-10	0.00E+00	1.56E+01	2.28E-02	2.12E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.60E-09	1.26E-11	0.00E+00	1.15E-02	1.55E-02	2.30E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	3.46E-07	4.53E-10	0.00E+00	3.35E+00	5.32E-01	8.35E-05	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	9.06E-08	1.19E-10	0.00E+00	1.57E+01	2.32E-02	2.13E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.60E-06	8.65E-09	0.00E+00	8.68E-02	9.65E-03	4.32E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.74E-03	2.28E-06	0.00E+00	2.13E+01	2.54E+00	1.14E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.48E-05	9.79E-08	0.00E+00	9.19E-01	1.09E-01	4.89E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.94E-03	2.53E-06	0.00E+00	2.32E+01	2.83E+00	1.27E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.02E-03	1.34E-06	0.00E+00	2.56E+02	2.69E+01	1.32E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[blue box] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[orange box] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[green box] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-15 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (1f) NES Sensitivity Analysis – Global Warming – Reduced HER

Radionuclide	Perch Creek	Ottawa River	Garden Area	Grazing Area	Perch Creek	Ottawa River	Screening Criterion						Screen In?	Comment
	Surface Water	Surface Water	Soil	Soil	Sediment	Sediment	Surface Water	Surface Water	Soil	Soil	Sediment	Sediment		
	(Bq/L)	(Bq/L)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/L)	(Bq/L)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/kg)		
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER														
Ac227	1.72E-05	2.25E-08	0.00E+00	1.47E-02	9.61E-03	3.50E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	3.83E-06	5.02E-09	0.00E+00	1.90E-01	4.26E-01	3.03E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	1.37E-03	1.79E-06	0.00E+00	4.80E+00	1.88E+01	1.19E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	1.31E-06	1.72E-09	0.00E+00	2.06E-02	1.87E-02	1.37E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	9.92E-02	1.28E-04	1.70E+01	1.37E+00	1.79E+02	5.99E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	7.17E-03	9.39E-06	0.00E+00	2.99E-02	4.29E+00	1.12E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	7.44E-29	9.74E-32	0.00E+00	4.24E-24	3.92E-23	1.15E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	5.53E-06	7.24E-09	0.00E+00	3.52E-01	3.20E-01	6.64E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	1.58E-11	2.06E-14	0.00E+00	3.27E-04	4.50E-08	3.11E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	1.85E-05	2.43E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-02	5.51E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.70E-02	4.85E-05	0.00E+00	2.53E+01	3.37E+03	1.37E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.36E-08	4.40E-11	0.00E+00	3.42E-04	7.58E-05	3.63E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	4.09E-04	5.36E-07	0.00E+00	4.56E+02	8.10E+00	1.29E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	2.13E-05	2.79E-08	0.00E+00	2.55E+01	3.39E-01	4.71E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.47E-05	1.92E-08	0.00E+00	2.79E-01	9.25E-02	2.47E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	4.69E-06	6.14E-09	0.00E+00	3.75E-01	1.86E-03	3.26E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.44E-05	4.50E-08	0.00E+00	2.57E-04	7.54E-04	5.53E-08	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	6.43E-06	8.42E-09	0.00E+00	3.81E-02	6.75E-02	3.99E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	4.82E-05	6.31E-08	0.00E+00	1.22E+01	3.97E-02	6.53E-05	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	1.30E-03	1.69E-06	0.00E+00	1.13E+01	7.48E-02	6.51E-05	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	1.80E-02	2.36E-05	0.00E+00	2.35E+01	8.56E+02	4.91E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.31E-10	5.65E-13	0.00E+00	3.95E-10	2.49E-05	5.85E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.32E-05	1.73E-08	0.00E+00	1.77E-02	6.27E-01	3.61E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	7.83E-06	1.02E-08	0.00E+00	1.32E+01	7.43E-01	7.52E-05	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	2.87E-06	3.76E-09	0.00E+00	3.26E+01	2.71E-02	3.28E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	1.58E-08	2.07E-11	0.00E+00	1.00E-03	7.76E-06	6.30E-10	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	8.42E-01	1.10E-03	0.00E+00	2.22E+00	1.51E+02	3.02E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	1.42E-07	1.89E-10	0.00E+00	3.26E+01	2.72E-02	3.28E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.01E-09	1.18E-11	0.00E+00	5.30E-02	1.14E-02	2.16E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	3.49E-07	4.57E-10	0.00E+00	7.77E+00	3.99E-01	8.43E-05	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	1.42E-07	1.86E-10	0.00E+00	3.28E+01	2.96E-02	3.31E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	5.98E-06	7.84E-09	0.00E+00	9.67E-02	8.73E-03	3.89E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.59E-03	2.09E-06	0.00E+00	2.38E+01	2.33E+00	1.04E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	6.84E-05	8.96E-08	0.00E+00	1.03E+00	9.99E-02	4.45E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.78E-03	2.33E-06	0.00E+00	2.59E+01	2.59E+00	1.15E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.03E-03	1.35E-06	0.00E+00	4.56E+02	2.69E+01	1.33E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-16 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (3) Disruptive Event – Human Intrusion, House with Basement – Resident (Chronic)

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)														
Ac227	1.87E-05	2.45E-08	5.82E-04	1.56E-02	1.07E-02	3.89E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.77E-06	6.25E-09	6.25E-05	2.09E-01	6.53E-01	3.75E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.54E-03	3.33E-06	5.40E+00	5.70E+00	4.67E+01	2.39E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.43E-06	3.19E-09	1.85E-03	2.41E-02	4.69E-02	2.75E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.18E-02	1.06E-04	3.52E+01	1.70E+00	1.52E+02	4.95E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-03	8.13E-06	1.67E-01	2.63E-02	3.70E+00	9.85E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	8.37E+00	9.96E-23	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.77E-06	8.87E-09	2.81E-03	3.71E-01	5.45E-01	8.08E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.50E-11	5.89E-14	6.27E+01	4.86E-04	1.40E-07	9.73E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.45E-05	3.20E-08	5.40E-04	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	1.72E+03	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.45E-02	4.52E-05	6.17E-02	2.41E+01	3.35E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.85E-08	5.04E-11	4.84E-06	3.57E-04	7.90E-05	3.89E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.86E-04	7.68E-07	1.67E+01	5.71E+02	9.85E+00	1.64E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	3.53E-05	4.62E-08	7.31E-01	2.98E+01	8.03E-01	7.80E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.67E-05	2.18E-08	4.07E-02	2.89E-01	1.67E-01	2.78E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.49E-06	9.81E-09	7.32E+00	4.18E-01	3.49E-03	5.00E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-05	4.63E-08	6.23E-04	2.54E-04	6.70E-04	1.01E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.25E-06	1.21E-08	6.93E-04	4.22E-02	7.89E-02	4.44E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	9.74E-05	1.28E-07	1.19E-01	1.38E+01	5.40E-02	1.07E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	2.62E-03	3.39E-06	1.18E-01	1.26E+01	1.06E-01	1.07E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-02	2.86E-05	3.02E+00	2.42E+01	9.91E+02	4.54E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	5.29E+00	9.11E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-05	2.09E-08	2.25E-03	1.83E-02	7.25E-01	3.34E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.37E-05	1.79E-08	1.21E-01	1.54E+01	1.10E+00	1.23E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	6.06E-06	7.93E-09	9.21E-01	4.73E+01	6.84E-02	6.65E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.36E-08	4.40E-11	6.47E+01	1.39E-03	2.32E-05	1.31E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	4.98E-01	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	2.89E-07	3.83E-10	9.21E-01	4.73E+01	6.86E-02	6.66E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.97E-09	1.31E-11	6.02E-04	8.33E-02	1.43E-02	2.40E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.15E-07	5.43E-10	2.42E-01	1.16E+01	5.16E-01	1.00E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	2.86E-07	3.75E-10	9.21E-01	4.76E+01	7.05E-02	6.70E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.74E-06	8.83E-09	9.65E-03	1.02E-01	9.36E-03	4.32E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.78E-03	2.33E-06	2.73E+00	2.50E+01	2.47E+00	1.14E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.62E-05	9.99E-08	1.15E-01	1.08E+00	1.06E-01	4.89E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.97E-03	2.57E-06	2.50E+00	2.72E+01	2.74E+00	1.25E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.36E-03	1.78E-06	1.69E+01	5.70E+02	3.59E+01	1.71E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue shading] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Orange shading] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green shading] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-17 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (4) Disruptive Event – Enhanced Erosion Case

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(4) Disruptive Event - Enhanced Erosion Case														
Ac227	6.55E-05	8.58E-08	0.00E+00	7.70E-02	1.28E-02	2.18E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	2.63E-06	7.21E-09	0.00E+00	1.77E-01	4.84E-01	4.21E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	1.03E-03	3.31E-06	0.00E+00	4.86E+00	4.47E+01	3.41E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	9.86E-07	3.17E-09	0.00E+00	7.48E-03	4.48E-02	9.27E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.17E-02	1.06E-04	1.70E+01	1.70E+00	1.52E+02	4.95E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-03	8.13E-06	0.00E+00	2.63E-02	3.70E+00	9.85E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	4.15E-29	9.30E-32	0.00E+00	9.71E-23	4.01E-23	1.22E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	7.09E-06	1.13E-08	0.00E+00	2.27E-01	5.77E-01	1.01E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	1.94E-10	3.10E-13	0.00E+00	4.25E-04	5.12E-07	4.92E-10	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	1.62E+00	2.14E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.22E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.08E-02	4.46E-05	0.00E+00	2.34E+01	3.27E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.47E-08	4.55E-11	0.00E+00	3.00E-04	6.67E-05	3.62E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.00E-03	6.77E-06	0.00E+00	2.57E+02	7.54E+00	7.26E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	1.62E-04	2.21E-07	0.00E+00	7.67E+00	3.07E-01	3.63E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.76E-05	2.39E-08	0.00E+00	2.31E-01	1.94E-01	3.04E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	1.01E-05	1.37E-08	0.00E+00	3.63E-01	3.82E-03	6.75E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-05	4.63E-08	0.00E+00	9.93E-04	6.69E-04	1.60E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	8.13E-06	1.20E-08	0.00E+00	1.74E-01	8.30E-02	2.51E-05	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	2.67E-04	3.50E-07	0.00E+00	6.02E+00	4.72E-02	1.01E-03	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	5.25E-03	6.81E-06	0.00E+00	5.83E+00	8.99E-02	1.01E-03	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	8.70E-03	2.85E-05	0.00E+00	1.44E+01	9.89E+02	4.64E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	1.96E-10	6.43E-13	0.00E+00	9.08E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	6.36E-06	2.09E-08	0.00E+00	1.31E-02	7.23E-01	3.40E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	7.76E-05	1.19E-07	0.00E+00	5.24E+00	1.07E+00	1.18E-03	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	2.91E-04	4.32E-07	0.00E+00	1.44E+01	4.74E+00	1.68E-02	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	4.08E-08	5.37E-11	0.00E+00	1.31E-03	1.95E-05	1.54E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	3.50E-05	9.64E-08	0.00E+00	1.44E+01	4.81E+00	1.68E-02	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.52E-07	4.18E-10	0.00E+00	6.26E-02	3.90E-02	7.36E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	1.22E-05	3.35E-08	0.00E+00	4.85E+00	2.56E+00	5.96E-03	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	3.55E-05	9.77E-08	0.00E+00	1.44E+01	6.24E+00	1.74E-02	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	8.41E-06	1.10E-08	0.00E+00	6.56E-02	1.04E-02	5.48E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	2.20E-03	2.89E-06	0.00E+00	1.63E+01	2.75E+00	1.44E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	9.47E-05	1.24E-07	0.00E+00	7.01E-01	1.18E-01	6.18E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	2.43E-03	3.19E-06	0.00E+00	1.77E+01	3.05E+00	1.59E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	5.35E-03	7.14E-06	0.00E+00	2.53E+02	2.53E+01	6.81E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-18 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (5) Disruptive Event – Localized Cover Failure

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(5) Disruptive Event - Localized Cover Failure														
Ac227	1.86E-05	2.43E-08	0.00E+00	1.43E-02	1.06E-02	3.86E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	5.27E-06	6.90E-09	0.00E+00	2.20E-01	7.97E-01	4.34E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	9.33E-03	1.22E-05	0.00E+00	2.08E+01	1.94E+02	7.69E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	6.88E-06	9.01E-09	0.00E+00	1.54E-02	1.61E-01	8.90E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	7.97E-02	1.03E-04	1.70E+01	1.17E+00	1.48E+02	4.82E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	5.02E-03	6.57E-06	0.00E+00	3.11E-02	3.05E+00	8.63E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	1.38E-23	1.80E-26	0.00E+00	3.97E-13	3.94E-20	1.56E-23	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.71E-06	8.78E-09	0.00E+00	3.60E-01	5.52E-01	8.08E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	3.71E-09	4.86E-12	0.00E+00	8.64E-02	1.11E-05	7.53E-09	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.51E-05	3.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	2.54E-02	3.33E-05	0.00E+00	1.61E+01	2.50E+03	1.07E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.30E-08	4.33E-11	0.00E+00	2.55E-04	7.06E-05	3.60E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	6.75E-04	8.84E-07	0.00E+00	6.10E+02	1.07E+01	1.82E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	4.05E-05	5.30E-08	0.00E+00	2.96E+01	9.43E-01	8.93E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.62E-05	2.12E-08	0.00E+00	2.79E-01	1.70E-01	2.76E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	2.71E-05	3.54E-08	0.00E+00	1.46E+00	1.07E-02	1.33E-05	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.50E-05	4.58E-08	0.00E+00	4.12E-04	5.49E-04	3.45E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	1.45E-05	1.90E-08	0.00E+00	3.77E-02	7.84E-02	4.40E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	1.08E-04	1.41E-07	0.00E+00	1.45E+01	5.73E-02	1.19E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	3.11E-03	4.03E-06	0.00E+00	1.32E+01	1.13E-01	1.19E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	1.87E-02	2.44E-05	0.00E+00	1.34E+01	6.82E+02	3.18E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	1.67E-08	2.18E-11	0.00E+00	4.39E-05	5.21E-04	3.41E-09	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.36E-05	1.78E-08	0.00E+00	9.71E-03	4.98E-01	2.33E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.51E-05	1.98E-08	0.00E+00	1.63E+01	1.17E+00	1.36E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	8.81E-06	1.15E-08	0.00E+00	5.30E+01	1.04E-01	9.78E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	4.92E-06	6.44E-09	0.00E+00	4.12E-01	3.20E-03	1.65E-07	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	5.05E-01	6.62E-04	0.00E+00	1.02E+01	8.27E+01	2.12E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	4.22E-07	5.59E-10	0.00E+00	5.30E+01	1.04E-01	9.78E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.00E-08	1.31E-11	0.00E+00	8.37E-02	1.44E-02	2.41E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.43E-07	5.80E-10	0.00E+00	1.27E+01	5.26E-01	1.07E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	4.18E-07	5.48E-10	0.00E+00	5.33E+01	1.06E-01	9.85E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.70E-06	8.78E-09	0.00E+00	1.00E-01	9.31E-03	4.29E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.77E-03	2.32E-06	0.00E+00	2.47E+01	2.46E+00	1.13E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.59E-05	9.93E-08	0.00E+00	1.06E+00	1.06E-01	4.86E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.96E-03	2.56E-06	0.00E+00	2.68E+01	2.73E+00	1.25E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.52E-03	1.99E-06	0.00E+00	6.10E+02	3.89E+01	1.92E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue legend box] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Orange legend box] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green legend box] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-19 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (6) Disruptive Event – Localized Liner Failure

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(6) Disruptive Event - Localized Liner Failure														
Ac227	1.99E-05	2.61E-08	0.00E+00	1.29E-02	1.15E-02	4.16E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	3.44E-06	4.50E-09	0.00E+00	1.79E-01	5.11E-01	2.69E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.00E-03	2.62E-06	0.00E+00	4.47E+00	8.72E+01	3.74E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	1.85E-06	2.42E-09	0.00E+00	1.85E-02	8.67E-02	4.22E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	1.17E-01	1.52E-04	1.70E+01	1.41E+00	2.11E+02	6.83E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.59E-03	8.64E-06	0.00E+00	2.33E-02	4.13E+00	1.05E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	0.00E+00	1.46E-27	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	4.80E-06	6.29E-09	0.00E+00	3.24E-01	7.11E-01	5.69E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	1.03E-11	1.35E-14	0.00E+00	1.87E-04	3.30E-08	2.28E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	1.66E-05	2.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.80E-02	4.98E-05	0.00E+00	2.11E+01	3.92E+03	1.33E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	4.67E-08	6.12E-11	0.00E+00	3.05E-04	1.35E-04	5.32E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	8.66E-04	1.14E-06	0.00E+00	4.33E+02	3.87E+01	5.63E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	2.50E-05	3.28E-08	0.00E+00	2.38E+01	7.39E-01	5.53E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.24E-05	1.62E-08	0.00E+00	2.57E-01	2.80E-01	2.04E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	4.38E-06	5.74E-09	0.00E+00	3.52E-01	2.19E-03	2.99E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	4.17E-05	5.46E-08	0.00E+00	2.18E-04	9.43E-04	1.62E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	1.01E-05	1.32E-08	0.00E+00	3.30E-02	8.52E-02	4.75E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	6.50E-05	8.51E-08	0.00E+00	1.15E+01	5.41E-02	8.25E-05	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	1.73E-03	2.24E-06	0.00E+00	1.05E+01	1.06E-01	8.23E-05	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.34E-02	3.06E-05	0.00E+00	1.97E+01	1.22E+03	6.04E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	1.31E-12	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.71E-05	2.24E-08	0.00E+00	1.48E-02	8.94E-01	4.43E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	9.94E-06	1.30E-08	0.00E+00	1.26E+01	1.10E+00	9.50E-05	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	3.98E-06	5.20E-09	0.00E+00	3.37E+01	4.47E-02	4.35E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	8.57E-09	1.12E-11	0.00E+00	4.62E-04	8.22E-06	3.51E-10	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	1.01E+00	1.32E-03	0.00E+00	9.37E-01	1.92E+02	2.67E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	1.90E-07	2.52E-10	0.00E+00	3.37E+01	4.47E-02	4.36E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.73E-09	1.27E-11	0.00E+00	5.85E-02	1.46E-02	2.34E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	3.96E-07	5.19E-10	0.00E+00	8.20E+00	5.38E-01	9.60E-05	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	1.88E-07	2.46E-10	0.00E+00	3.39E+01	4.61E-02	4.39E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	8.02E-06	1.05E-08	0.00E+00	8.90E-02	1.14E-02	5.05E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	2.10E-03	2.75E-06	0.00E+00	2.19E+01	3.00E+00	1.32E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	9.04E-05	1.18E-07	0.00E+00	9.44E-01	1.29E-01	5.69E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	2.36E-03	3.09E-06	0.00E+00	2.38E+01	3.36E+00	1.48E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	4.89E-03	6.40E-06	0.00E+00	4.32E+02	1.36E+02	6.08E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:
N/A - screening criterion not available
DCC - dose conversion coefficient

[light blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[light orange] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[light green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.
United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-20 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (7) Disruptive Event – Damage to Berm

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(7) Disruptive Event - Damage to Berm														
Ac227	1.96E-05	2.57E-08	0.00E+00	2.10E-02	1.06E-02	3.96E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	5.30E-06	6.94E-09	0.00E+00	2.16E-01	7.01E-01	4.17E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.66E-03	3.48E-06	0.00E+00	8.35E+00	4.81E+01	2.47E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.55E-06	3.33E-09	0.00E+00	3.85E-02	4.83E-02	2.85E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	4.92E-02	6.37E-05	1.70E+01	2.91E+00	9.57E+01	2.90E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.24E-03	8.18E-06	0.00E+00	3.10E-02	3.73E+00	1.19E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	0.00E+00	9.97E-23	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	8.48E-06	1.11E-08	0.00E+00	4.15E-01	7.26E-01	1.03E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.80E-11	6.28E-14	0.00E+00	4.86E-04	1.47E-07	1.02E-10	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.92E-05	3.83E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	4.85E-02	6.35E-05	0.00E+00	3.60E+01	3.96E+03	1.54E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	5.82E-08	7.62E-11	0.00E+00	4.97E-04	1.20E-04	6.03E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	6.89E-04	9.03E-07	0.00E+00	6.80E+02	1.03E+01	1.79E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	4.99E-05	6.53E-08	0.00E+00	3.90E+01	1.11E+00	1.10E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.98E-05	2.60E-08	0.00E+00	3.20E-01	2.03E-01	3.44E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	8.59E-06	1.12E-08	0.00E+00	4.58E-01	3.95E-03	5.78E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.60E-05	4.72E-08	0.00E+00	3.88E-04	6.20E-04	1.04E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.41E-06	1.23E-08	0.00E+00	5.89E-02	7.91E-02	4.51E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	1.36E-04	1.78E-07	0.00E+00	1.57E+01	5.89E-02	1.42E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	3.79E-03	4.91E-06	0.00E+00	1.42E+01	1.16E-01	1.41E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.23E-02	2.91E-05	0.00E+00	4.11E+01	1.00E+03	4.60E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	9.88E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.63E-05	2.13E-08	0.00E+00	3.11E-02	7.33E-01	3.38E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.79E-05	2.35E-08	0.00E+00	1.76E+01	1.20E+00	1.62E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	7.83E-06	1.03E-08	0.00E+00	6.01E+01	8.85E-02	8.61E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.38E-08	4.43E-11	0.00E+00	1.40E-03	2.33E-05	1.32E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.24E-01	9.48E-04	0.00E+00	2.00E+00	1.31E+02	2.54E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	3.74E-07	4.96E-10	0.00E+00	6.01E+01	8.87E-02	8.62E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.02E-08	1.34E-11	0.00E+00	1.09E-01	1.42E-02	2.47E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.49E-07	5.88E-10	0.00E+00	1.46E+01	5.19E-01	1.08E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	3.71E-07	4.85E-10	0.00E+00	6.05E+01	9.12E-02	8.68E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.46E-06	8.46E-09	0.00E+00	1.09E-01	8.79E-03	4.15E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.71E-03	2.24E-06	0.00E+00	2.87E+01	2.33E+00	1.10E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.32E-05	9.59E-08	0.00E+00	1.23E+00	9.99E-02	4.72E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.88E-03	2.46E-06	0.00E+00	3.25E+01	2.56E+00	1.21E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.44E-03	1.88E-06	0.00E+00	6.80E+02	3.75E+01	1.82E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[light blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[light orange] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[light green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-21 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (8) Dose Optimization –Wastes Grouted in Steel Liners

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion						Screen In?	Comment
							Surface Water (Bq/L)	Surface Water (Bq/L)	Soil (Bq/kg)	Soil (Bq/kg)	Sediment (Bq/kg)	Sediment (Bq/kg)		
(8) Dose Optimization - Wastes Grouted into Steel Liners														
Ac227	1.81E-05	2.38E-08	0.00E+00	1.56E-02	1.03E-02	3.77E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	4.77E-06	6.25E-09	0.00E+00	2.09E-01	6.53E-01	3.76E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.55E-03	3.33E-06	0.00E+00	5.71E+00	4.68E+01	2.40E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.44E-06	3.19E-09	0.00E+00	2.42E-02	4.70E-02	2.75E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	5.00E-02	6.46E-05	1.70E+01	1.47E+00	9.27E+01	3.05E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-03	8.13E-06	0.00E+00	2.63E-02	3.70E+00	9.85E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	7.00E-29	9.15E-32	0.00E+00	1.04E-22	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	6.78E-06	8.88E-09	0.00E+00	3.72E-01	5.45E-01	8.09E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.51E-11	5.90E-14	0.00E+00	4.87E-04	1.40E-07	9.74E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.45E-05	3.20E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-02	5.51E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.46E-02	4.53E-05	0.00E+00	2.42E+01	3.35E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.85E-08	5.04E-11	0.00E+00	3.58E-04	7.88E-05	3.89E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	5.87E-04	7.68E-07	0.00E+00	5.71E+02	9.86E+00	1.64E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	3.53E-05	4.62E-08	0.00E+00	2.99E+01	8.04E-01	7.81E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.67E-05	2.18E-08	0.00E+00	2.90E-01	1.67E-01	2.79E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.50E-06	9.82E-09	0.00E+00	4.18E-01	3.49E-03	5.00E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.54E-05	4.63E-08	0.00E+00	2.54E-04	6.71E-04	1.01E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.23E-06	1.21E-08	0.00E+00	4.22E-02	7.63E-02	4.30E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	9.75E-05	1.28E-07	0.00E+00	1.38E+01	5.28E-02	1.07E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	2.62E-03	3.39E-06	0.00E+00	1.26E+01	1.04E-01	1.07E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-02	2.86E-05	0.00E+00	2.42E+01	9.92E+02	4.55E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	9.12E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-05	2.09E-08	0.00E+00	1.83E-02	7.26E-01	3.34E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.37E-05	1.79E-08	0.00E+00	1.54E+01	1.07E+00	1.23E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	6.06E-06	7.93E-09	0.00E+00	4.74E+01	6.85E-02	6.66E-05	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.37E-08	4.41E-11	0.00E+00	1.40E-03	2.32E-05	1.31E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.37E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	2.89E-07	3.84E-10	0.00E+00	4.74E+01	6.86E-02	6.66E-05	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	9.98E-09	1.31E-11	0.00E+00	8.34E-02	1.43E-02	2.40E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.04E-07	5.29E-10	0.00E+00	1.16E+01	4.98E-01	9.76E-05	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	2.87E-07	3.75E-10	0.00E+00	4.77E+01	7.06E-02	6.71E-05	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.74E-06	8.83E-09	0.00E+00	1.02E-01	9.37E-03	4.32E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.70E-03	2.23E-06	0.00E+00	2.50E+01	2.36E+00	1.09E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.31E-05	9.58E-08	0.00E+00	1.08E+00	1.02E-01	4.70E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.83E-03	2.39E-06	0.00E+00	2.72E+01	2.54E+00	1.17E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.36E-03	1.78E-06	0.00E+00	5.71E+02	3.60E+01	1.71E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

(Blue) Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

(Peach) Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

(Green) No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-22 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (11) Defence-in-Depth – Role of Geosphere

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(11) Defence-in-Depth - Role of Geosphere														
Ac227	9.33E-05	1.22E-07	0.00E+00	1.56E-02	5.46E-02	5.42E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	1.01E-05	1.32E-08	0.00E+00	2.09E-01	5.84E+00	7.91E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	6.64E-03	8.70E-06	0.00E+00	5.70E+00	3.26E+02	1.33E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	6.32E-06	8.28E-09	0.00E+00	2.41E-02	3.31E-01	1.53E-05	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	8.26E-02	1.07E-04	1.70E+01	1.70E+00	1.56E+02	5.00E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.21E-03	8.13E-06	0.00E+00	2.63E-02	3.70E+00	9.85E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	3.68E-16	4.81E-19	0.00E+00	4.33E-18	2.12E-10	6.05E-16	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	1.45E-05	1.90E-08	0.00E+00	3.71E-01	2.17E+00	1.73E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	2.14E-09	2.80E-12	0.00E+00	4.86E-04	5.01E-04	4.37E-09	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	5.56E-05	7.28E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-02	5.51E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.44E-02	4.50E-05	0.00E+00	2.41E+01	3.33E+03	1.21E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	4.51E-08	5.91E-11	0.00E+00	3.57E-04	9.84E-05	4.44E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	2.15E-03	2.82E-06	0.00E+00	5.71E+02	9.84E+01	2.06E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	1.27E-04	1.66E-07	0.00E+00	2.98E+01	4.94E+00	2.69E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	3.58E-05	4.69E-08	0.00E+00	2.89E-01	9.66E-01	6.02E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	2.25E-05	2.94E-08	0.00E+00	4.18E-01	8.63E-01	1.51E-05	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.52E-05	4.61E-08	0.00E+00	2.54E-04	6.30E-04	5.12E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	1.25E-05	1.64E-08	0.00E+00	4.22E-02	1.07E-01	5.91E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	3.99E-04	5.22E-07	0.00E+00	1.38E+01	1.13E+00	4.05E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	3.32E-03	4.30E-06	0.00E+00	1.26E+01	3.03E-01	4.04E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.66E-02	3.49E-05	0.00E+00	2.42E+01	1.31E+03	6.96E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	2.01E-09	2.64E-12	0.00E+00	9.12E-10	1.17E-04	3.28E-10	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.95E-05	2.55E-08	0.00E+00	1.83E-02	9.61E-01	5.53E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	5.07E-05	6.64E-08	0.00E+00	1.54E+01	7.76E+00	4.61E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	6.78E-05	8.88E-08	0.00E+00	4.73E+01	1.02E+01	1.49E-03	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	1.31E-07	1.71E-10	0.00E+00	1.39E-03	7.61E-04	4.77E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.12E-01	9.32E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	6.80E-06	8.95E-09	0.00E+00	4.73E+01	1.08E+01	1.49E-03	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	5.29E-08	6.93E-11	0.00E+00	8.33E-02	8.52E-02	1.26E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	3.03E-06	3.97E-09	0.00E+00	1.16E+01	4.84E+00	7.30E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	6.30E-06	8.25E-09	0.00E+00	4.76E+01	1.00E+01	1.52E-03	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	7.10E-06	9.30E-09	0.00E+00	1.02E-01	1.04E-02	4.60E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.86E-03	2.43E-06	0.00E+00	2.50E+01	2.73E+00	1.20E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.98E-05	1.05E-07	0.00E+00	1.08E+00	1.17E-01	5.19E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	2.07E-03	2.71E-06	0.00E+00	2.72E+01	3.05E+00	1.34E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.37E-03	1.79E-06	0.00E+00	5.70E+02	3.93E+01	1.74E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Peach] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-23 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (12) Defence-in-Depth – Role of Cover

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(12) Defence-in-Depth - Role of Cover														
Ac227	1.90E-05	2.49E-08	0.00E+00	1.39E-02	1.08E-02	3.96E-06	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**
Ag108m	1.18E-05	1.54E-08	0.00E+00	3.86E-01	1.22E+00	7.35E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.86E-02	3.75E-05	0.00E+00	2.32E+01	9.27E+02	1.79E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.21E-05	2.90E-08	0.00E+00	1.71E-02	7.15E-01	1.95E-05	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	7.53E-02	9.73E-05	1.70E+01	2.00E+00	1.42E+02	4.59E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	7.74E-03	1.01E-05	0.00E+00	2.93E-02	5.05E+00	9.55E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.70E-23	8.77E-26	0.00E+00	7.14E-13	4.29E-18	7.74E-23	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	7.39E-06	9.68E-09	0.00E+00	3.84E-01	5.97E-01	8.88E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	1.95E-08	2.55E-11	0.00E+00	2.03E-01	5.67E-05	3.93E-08	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.72E-05	3.56E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	7.47E+00	9.78E-03	6.34E-01	4.28E-01	6.27E+01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.56E-02	4.66E-05	0.00E+00	2.64E+01	3.22E+03	1.12E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	4.26E-08	5.57E-11	0.00E+00	4.06E-04	8.72E-05	4.29E-09	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**
Nb93m	9.38E-04	1.23E-06	0.00E+00	7.80E+02	1.39E+01	2.55E-03	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**
Nb94	6.96E-05	9.12E-08	0.00E+00	3.77E+01	1.39E+00	1.52E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.84E-05	2.41E-08	0.00E+00	3.11E-01	1.82E-01	3.05E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	1.13E-04	1.48E-07	0.00E+00	3.99E+00	4.04E-02	5.48E-05	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	6.76E-05	8.85E-08	0.00E+00	2.38E-04	5.41E-04	8.49E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	3.33E-05	4.36E-08	0.00E+00	3.67E-02	8.05E-02	4.52E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	1.35E-04	1.77E-07	0.00E+00	1.67E+01	6.69E-02	1.50E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	1.32E-02	1.71E-05	0.00E+00	1.52E+01	1.32E-01	1.50E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	6.31E-02	8.27E-05	0.00E+00	6.25E+00	2.88E+03	4.39E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	9.16E-06	1.20E-08	0.00E+00	1.92E-05	5.06E-01	1.48E-06	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	4.59E-05	6.01E-08	0.00E+00	4.54E-03	2.10E+00	3.20E-05	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**
Ra226	1.90E-05	2.48E-08	0.00E+00	1.89E+01	1.36E+00	1.71E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	1.57E-05	2.05E-08	0.00E+00	7.26E+01	1.92E-01	1.76E-04	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	1.86E-05	2.44E-08	0.00E+00	8.23E-01	9.93E-03	6.28E-07	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	1.13E+00	1.48E-03	0.00E+00	1.98E+00	2.07E+02	2.88E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	7.53E-07	9.98E-10	0.00E+00	7.26E+01	1.92E-01	1.76E-04	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.03E-08	1.35E-11	0.00E+00	9.07E-02	1.47E-02	2.49E-06	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**
Th230	5.18E-07	6.78E-10	0.00E+00	1.64E+01	5.56E-01	1.25E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	7.46E-07	9.77E-10	0.00E+00	7.31E+01	1.94E-01	1.77E-04	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	6.78E-06	8.88E-09	0.00E+00	1.05E-01	9.43E-03	4.36E-07	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**
U234	1.79E-03	2.34E-06	0.00E+00	2.59E+01	2.50E+00	1.15E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	7.68E-05	1.01E-07	0.00E+00	1.12E+00	1.07E-01	4.93E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.98E-03	2.60E-06	0.00E+00	2.81E+01	2.77E+00	1.27E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	2.06E-03	2.70E-06	0.00E+00	7.80E+02	5.02E+01	2.65E-03	N/A	N/A	N/A	N/A	N/A	N/A	Yes	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Light blue shading] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Light orange shading] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Light green shading] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-24 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (13) Defence-in-Depth – Role of Base Liner

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(13) Defence-in-Depth - Role of Base Liner														
Ac227	2.50E-05	3.27E-08	0.00E+00	7.02E-07	1.47E-02	5.15E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	3.41E-08	4.47E-11	0.00E+00	6.09E-09	3.29E-02	3.08E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	5.36E-04	7.02E-07	0.00E+00	1.17E-05	2.89E+01	1.21E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	4.86E-07	6.36E-10	0.00E+00	1.54E-08	2.82E-02	1.35E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	2.86E-01	3.70E-04	1.70E+01	1.46E-01	4.19E+02	1.39E-02	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	8.22E-03	1.08E-05	0.00E+00	8.29E-07	5.17E+00	1.20E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	1.63E-28	2.13E-31	0.00E+00	2.01E-30	9.38E-23	2.81E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	3.92E-06	5.13E-09	0.00E+00	1.11E-06	7.76E-01	4.49E-05	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	1.31E-23	1.72E-26	0.00E+00	5.94E-25	2.60E-18	2.83E-23	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	5.04E-07	6.59E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.21E-02	5.51E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	5.21E-02	6.82E-05	0.00E+00	7.71E-04	5.58E+03	1.60E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	6.93E-08	9.08E-11	0.00E+00	6.10E-09	2.02E-04	7.34E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	9.02E-04	1.18E-06	0.00E+00	1.59E-02	4.14E+01	6.53E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	4.60E-06	6.03E-09	0.00E+00	3.73E-06	2.12E-01	8.98E-06	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	8.52E-06	1.12E-08	0.00E+00	8.88E-07	3.26E-01	1.43E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	1.44E-15	1.89E-18	0.00E+00	9.50E-17	5.53E-11	1.11E-15	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	4.17E-05	5.46E-08	0.00E+00	8.38E-08	1.26E-03	7.96E-08	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	6.92E-06	9.06E-09	0.00E+00	1.43E-06	1.08E-01	5.87E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	1.82E-05	2.38E-08	0.00E+00	1.19E-05	5.29E-02	5.66E-05	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	3.45E-04	4.48E-07	0.00E+00	1.13E-05	1.03E-01	5.64E-05	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	1.92E-02	2.52E-05	0.00E+00	2.62E-04	1.05E+03	5.34E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	3.80E-10	4.97E-13	0.00E+00	9.39E-13	2.19E-05	6.20E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.41E-05	1.84E-08	0.00E+00	2.32E-07	7.69E-01	3.92E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	6.64E-06	8.70E-09	0.00E+00	1.34E-05	1.09E+00	6.55E-05	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	4.55E-11	5.95E-14	0.00E+00	1.01E-11	7.44E-06	6.67E-10	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	8.34E-11	1.09E-13	0.00E+00	1.84E-12	4.59E-07	3.05E-12	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	1.02E+00	1.34E-03	0.00E+00	9.35E-05	1.94E+02	2.86E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	4.47E-12	5.88E-15	0.00E+00	1.01E-11	7.37E-06	6.71E-10	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.19E-08	1.56E-11	0.00E+00	6.99E-07	1.96E-02	2.87E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	4.22E-07	5.52E-10	0.00E+00	2.40E-05	6.96E-01	1.03E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	3.35E-12	4.39E-15	0.00E+00	9.79E-12	5.54E-06	6.82E-10	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	8.09E-06	1.06E-08	0.00E+00	1.90E-06	1.18E-02	5.28E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	2.13E-03	2.78E-06	0.00E+00	4.98E-04	3.11E+00	1.39E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	9.14E-05	1.20E-07	0.00E+00	2.14E-05	1.34E-01	5.97E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	2.39E-03	3.13E-06	0.00E+00	5.60E-04	3.49E+00	1.56E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	5.44E-03	7.12E-06	0.00E+00	1.61E-02	1.52E+02	7.06E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue legend] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Orange legend] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green legend] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-25 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (14) Defence-in-Depth – Series of Landslides

Radionuclide	Perch Creek	Ottawa River	Garden Area	Grazing Area	Perch Creek	Ottawa River	Screening Criterion						Screen In?	Comment
	Surface Water	Surface Water	Soil	Soil	Sediment	Sediment	Surface Water	Surface Water	Soil	Soil	Sediment	Sediment		
	(Bq/L)	(Bq/L)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/L)	(Bq/L)	(Bq/kg)	(Bq/kg)	(Bq/kg)	(Bq/kg)		
(14) Defence-in-Depth - Series of Landslides														
Ac227	4.56E-05	5.98E-08	0.00E+00	3.95E-02	1.52E-02	5.44E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	1.67E-05	1.54E-07	0.00E+00	2.03E+00	4.35E+00	8.61E-03	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.54E-03	3.33E-06	0.00E+00	1.49E+01	4.67E+01	3.30E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.43E-06	3.19E-09	0.00E+00	2.65E-02	4.69E-02	1.27E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	1.41E-02	1.83E-05	1.70E+01	3.69E+00	3.04E+01	5.28E-04	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.19E-03	8.13E-06	0.00E+00	3.64E-02	3.70E+00	1.24E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	0.00E+00	9.96E-23	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	1.05E-05	3.17E-08	0.00E+00	2.75E-01	8.34E-01	2.88E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	8.09E-10	2.33E-12	0.00E+00	4.86E-04	1.85E-06	3.31E-09	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	9.17E+00	1.33E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.61E-02	7.53E-05	0.00E+00	4.34E+01	3.86E+03	1.61E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	6.13E-08	8.15E-11	0.00E+00	3.27E-04	8.15E-05	6.56E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	2.62E-02	4.39E-05	0.00E+00	4.71E+02	1.29E+01	4.62E-02	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	9.91E-04	1.67E-06	0.00E+00	1.87E+01	5.98E-01	2.78E-03	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	5.36E-05	8.94E-08	0.00E+00	4.67E-01	4.11E-01	1.21E-04	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	3.46E-05	5.42E-08	0.00E+00	5.68E-01	9.47E-03	2.38E-05	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-05	4.63E-08	0.00E+00	6.91E-03	9.21E-04	1.90E-06	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.25E-06	1.27E-08	0.00E+00	1.16E-01	1.04E-01	6.31E-05	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	1.56E-03	2.08E-06	0.00E+00	1.49E+01	7.40E-02	8.78E-03	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	1.63E-02	2.12E-05	0.00E+00	1.29E+01	1.40E-01	8.75E-03	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-02	2.86E-05	0.00E+00	4.07E+01	9.91E+02	2.41E-01	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	9.11E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-05	2.09E-08	0.00E+00	3.11E-02	7.25E-01	1.86E-04	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	5.22E-04	1.34E-06	0.00E+00	1.75E+01	1.90E+00	1.01E-02	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	7.75E-04	2.14E-06	0.00E+00	2.44E+01	8.63E+00	1.12E-01	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.36E-08	4.40E-11	0.00E+00	1.39E-03	2.32E-05	1.39E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	1.75E-04	6.20E-07	0.00E+00	2.44E+01	8.71E+00	1.12E-01	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	5.81E-07	1.37E-09	0.00E+00	4.72E-02	3.60E-02	2.31E-04	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	5.09E-05	1.56E-07	0.00E+00	5.98E+00	3.05E+00	2.85E-02	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	1.77E-04	6.24E-07	0.00E+00	2.46E+01	1.06E+01	1.16E-01	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	2.19E-05	2.90E-08	0.00E+00	1.83E-01	9.59E-03	1.43E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	5.51E-03	7.29E-06	0.00E+00	4.59E+01	2.43E+00	3.59E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	2.37E-04	3.14E-07	0.00E+00	1.98E+00	1.04E-01	1.55E-05	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	6.04E-03	7.98E-06	0.00E+00	5.03E+01	2.65E+00	3.93E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	2.87E-02	4.38E-05	0.00E+00	4.86E+02	2.77E+01	4.29E-02	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:
N/A - screening criterion not available
DCC - dose conversion coefficient

[blue legend box] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[orange legend box] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[green legend box] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.
United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-26 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (15) What-If – Human Intrusion, Mass Excavation and Farming

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion						Screen In?	Comment
							Surface Water (Bq/L)	Surface Water (Bq/L)	Soil (Bq/kg)	Soil (Bq/kg)	Sediment (Bq/kg)	Sediment (Bq/kg)		
(15) What If - Human Intrusion, Mass Excavation and Farming														
Ac227	4.39E-05	5.75E-08	8.22E-03	7.38E-03	2.58E-02	8.81E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	2.57E-04	3.36E-07	5.21E+00	4.56E+00	2.60E+01	7.86E-03	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	4.24E-02	5.55E-05	2.68E+01	3.48E+01	1.34E+03	3.65E-02	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	4.18E-05	5.48E-08	2.12E-02	2.74E-02	1.32E+00	4.62E-05	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	4.39E+00	5.68E-03	1.70E+01	6.73E+01	6.43E+03	1.49E-01	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03	**Yes**	**Exceeded sediment (Perch Creek) criterion**
Cl36	2.05E-02	2.68E-05	1.48E-03	4.11E-02	1.25E+01	1.24E-04	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	1.39E-15	1.82E-18	1.01E-10	8.93E-11	6.97E-13	3.01E-16	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	1.29E-05	1.69E-08	3.11E-01	2.71E-01	2.55E+00	1.57E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.65E-05	6.08E-08	1.71E+00	1.49E+00	7.02E-02	3.97E-05	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	2.25E-04	2.95E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	3.66E-02	4.79E-05	6.34E-01	4.23E-01	1.42E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	1.14E-01	1.50E-04	1.84E+01	2.43E+01	1.21E+04	2.61E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	4.32E-08	5.66E-11	7.55E-05	1.53E-04	1.26E-04	5.20E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	6.72E-03	8.80E-06	2.11E+02	7.01E+02	1.57E+01	2.84E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	2.99E-04	3.91E-07	9.40E+00	2.08E+01	1.13E+00	7.14E-05	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	4.57E-05	5.99E-08	4.57E-01	3.99E-01	4.79E-01	2.36E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	1.31E-03	1.72E-06	1.31E+01	1.14E+01	3.92E-01	2.86E-04	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	1.57E-04	2.05E-07	3.60E-05	6.06E-04	9.28E-04	1.58E-06	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	7.43E-05	9.73E-08	6.37E-03	1.59E-02	1.83E-01	1.00E-05	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	7.66E-04	1.00E-06	1.81E+01	1.57E+01	1.28E-01	6.18E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	1.46E-01	1.90E-04	1.18E+01	1.45E+01	2.51E-01	6.17E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01	**Yes**	**Exceeded surface water (Perch Creek) criterion**
Pu239	1.02E-01	1.33E-04	1.68E+01	2.61E+01	4.06E+03	5.94E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	2.13E-07	2.80E-10	9.18E-05	1.43E-04	4.97E-03	1.45E-08	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	8.07E-05	1.06E-07	1.33E-02	2.07E-02	3.21E+00	4.71E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	1.02E-04	1.33E-07	1.79E+01	1.66E+01	2.59E+00	7.06E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	9.78E-05	1.28E-07	1.68E+01	4.04E+01	1.67E+00	1.35E-03	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	2.17E-04	2.84E-07	1.31E+00	1.21E+00	7.44E-02	3.44E-06	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	2.65E+00	3.48E-03	7.42E-01	1.30E+01	3.95E+02	3.34E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	2.25E-05	2.95E-08	1.68E+01	4.04E+01	1.66E+00	1.35E-03	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.25E-08	1.63E-11	3.74E-03	1.41E-02	1.96E-02	3.04E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	2.89E-06	3.78E-09	2.11E+00	5.33E+00	1.25E+00	2.75E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	2.27E-05	2.97E-08	1.68E+01	4.06E+01	1.51E+00	1.36E-03	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	8.74E-06	1.14E-08	9.17E-02	1.34E-01	1.28E-02	5.71E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	3.35E-03	4.39E-06	3.46E+01	5.06E+01	4.89E+00	2.19E-04	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	1.48E-04	1.94E-07	1.53E+00	2.24E+00	2.16E-01	9.69E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	3.90E-03	5.11E-06	4.04E+01	5.90E+01	5.70E+00	2.55E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	1.30E-02	1.70E-05	2.12E+02	7.72E+02	5.72E+01	2.97E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[Blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[Peach] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[Green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-27 Maximum Radionuclide Concentrations Predicted in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for Scenario (17) What-If – Permanent Bathtub

Radionuclide	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediment (Bq/kg)	Ottawa River Sediment (Bq/kg)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Surface Water (Bq/L)	Screening Criterion Soil (Bq/kg)	Screening Criterion Soil (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screening Criterion Sediment (Bq/kg)	Screen In?	Comment
(17) What If - Permanent Bathtub														
Ac227	5.52E-05	7.23E-08	0.00E+00	4.51E-02	1.24E-02	6.99E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ag108m	5.00E-06	6.55E-09	0.00E+00	2.10E-01	6.79E-01	3.97E-04	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
Am241	2.54E-03	3.33E-06	0.00E+00	5.91E+00	4.67E+01	2.39E-03	3.85E-01	3.85E-01	8.62E+02	8.62E+02	8.28E+03	8.28E+03		
Am243	2.43E-06	3.19E-09	0.00E+00	3.10E-02	4.69E-02	3.13E-06	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
C14	5.96E-02	7.71E-05	1.70E+01	1.71E+00	1.17E+02	3.56E-03	1.64E+02	1.64E+02	5.74E+02	5.74E+02	5.45E+03	5.45E+03		
Cl36	6.18E-03	8.09E-06	0.00E+00	2.64E-02	3.67E+00	9.82E-05	1.31E+03	1.31E+03	9.02E-01	9.02E-01	1.06E+02	1.06E+02		
Co60	6.99E-29	9.14E-32	0.00E+00	9.96E-23	4.02E-23	1.20E-28	1.35E+02	1.35E+02	9.05E+04	9.05E+04	1.03E+06	1.03E+06		
Cs135	8.36E-06	1.09E-08	0.00E+00	3.84E-01	9.70E-01	1.03E-04	3.48E+02	3.48E+02	1.97E+05	1.97E+05	4.36E+06	4.36E+06		
Cs137	4.55E-11	5.96E-14	0.00E+00	4.86E-04	1.41E-07	9.82E-11	7.27E+01	7.27E+01	5.54E+04	5.54E+04	7.12E+05	7.12E+05		
Cu29	4.96E-05	6.50E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	N/A	N/A	N/A	N/A	N/A		No DCC available for assessment
H3	4.22E-02	5.52E-05	6.34E-01	4.23E-01	1.60E-01	0.00E+00	1.74E+07	1.74E+07	3.20E+06	3.20E+06	2.60E+07	2.60E+07		
I129	3.44E-02	4.50E-05	0.00E+00	2.42E+01	3.32E+03	1.19E-01	7.63E+01	7.63E+01	1.59E+06	1.59E+06	1.57E+06	1.57E+06		
Mo93	3.92E-08	5.14E-11	0.00E+00	3.60E-04	8.03E-05	3.98E-09	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb93m	2.94E-03	3.85E-06	0.00E+00	8.83E+02	2.14E+01	4.35E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Nb94	1.19E-04	1.56E-07	0.00E+00	3.60E+01	1.44E+00	2.63E-04	1.95E+02	1.95E+02	1.15E+05	1.15E+05	3.08E+03	3.08E+03		
Ni59	1.81E-05	2.37E-08	0.00E+00	2.95E-01	3.44E-01	3.22E-05	2.56E+03	2.56E+03	1.24E+07	1.24E+07	4.30E+07	4.30E+07		
Ni63	7.71E-06	1.01E-08	0.00E+00	4.19E-01	3.58E-03	5.16E-06	9.09E+03	9.09E+03	8.77E+06	8.77E+06	3.25E+07	3.25E+07		
Np237	3.53E-05	4.63E-08	0.00E+00	2.72E-04	5.78E-04	1.01E-07	1.83E+01	1.83E+01	1.00E+03	1.00E+03	5.12E+00	5.12E+00		
Pa231	9.25E-06	1.21E-08	0.00E+00	1.29E-01	7.80E-02	7.87E-06	3.17E-01	3.17E-01	9.62E+02	9.62E+02	1.92E+03	1.92E+03		
Pb210	3.67E-04	4.80E-07	0.00E+00	1.49E+01	9.60E-02	4.00E-04	4.48E+01	4.48E+01	6.25E+04	6.25E+04	2.00E+05	2.00E+05		
Po210	9.81E-03	1.27E-05	0.00E+00	1.35E+01	1.81E-01	4.00E-04	5.80E-02	5.80E-02	4.44E+02	4.44E+02	6.80E+01	6.80E+01		
Pu239	2.18E-02	2.86E-05	0.00E+00	2.68E+01	9.91E+02	4.54E-02	6.79E-01	6.79E-01	8.00E+03	8.00E+03	2.58E+04	2.58E+04		
Pu241	4.91E-10	6.43E-13	0.00E+00	9.11E-10	2.84E-05	8.02E-11	2.50E+03	2.50E+03	2.94E+07	2.94E+07	9.48E+07	9.48E+07		
Pu242	1.60E-05	2.09E-08	0.00E+00	2.04E-02	7.25E-01	3.34E-05	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Ra226	5.06E-05	6.63E-08	0.00E+00	1.68E+01	1.69E+00	4.58E-04	3.64E-02	3.64E-02	2.77E+02	2.77E+02	1.12E+02	1.12E+02		
Ra228	3.91E-05	5.12E-08	0.00E+00	1.52E+02	3.00E-01	3.76E-04	1.00E+01	1.00E+01	1.28E+05	1.28E+05	4.76E+04	4.76E+04		
Sr90	3.36E-08	4.40E-11	0.00E+00	1.39E-03	2.32E-05	1.31E-09	1.83E+02	1.83E+02	1.18E+06	1.18E+06	1.14E+05	1.14E+05		
Tc99	7.15E-01	9.36E-04	0.00E+00	2.01E+00	1.28E+02	2.52E-03	2.47E+04	2.47E+04	4.61E+04	4.61E+04	3.39E+04	3.39E+04		
Th228	1.63E-06	2.17E-09	0.00E+00	1.52E+02	3.01E-01	3.76E-04	4.12E-03	4.12E-03	3.86E+02	3.86E+02	5.93E+01	5.93E+01		
Th229	1.45E-08	1.90E-11	0.00E+00	4.29E-01	1.11E-02	3.50E-06	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
Th230	8.28E-07	1.08E-09	0.00E+00	4.54E+01	4.50E-01	1.98E-04	3.81E-02	3.81E-02	2.66E+03	2.66E+03	4.10E+02	4.10E+02		
Th232	1.62E-06	2.12E-09	0.00E+00	1.54E+02	3.24E-01	3.77E-04	4.49E-02	4.49E-02	3.11E+03	3.11E+03	4.81E+02	4.81E+02		
U233	5.92E-06	7.75E-09	0.00E+00	1.05E-01	6.51E-03	3.86E-07	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**
U234	1.47E-03	1.93E-06	0.00E+00	2.59E+01	1.67E+00	9.61E-05	1.01E+01	1.01E+01	1.17E+03	1.17E+03	4.94E+02	4.94E+02		
U235	6.34E-05	8.30E-08	0.00E+00	1.12E+00	7.19E-02	4.14E-06	1.09E+01	1.09E+01	1.26E+03	1.26E+03	5.37E+02	5.37E+02		
U238	1.59E-03	2.09E-06	0.00E+00	2.81E+01	1.82E+00	1.04E-04	1.18E+01	1.18E+01	1.33E+03	1.33E+03	5.76E+02	5.76E+02		
Zr93	3.17E-03	4.15E-06	0.00E+00	8.83E+02	6.62E+01	4.10E-03	N/A	N/A	N/A	N/A	N/A	N/A	**Yes**	**No screening criteria and DCC available for assessment**

Notes:

N/A - screening criterion not available

DCC - dose conversion coefficient

[blue] Environmental Effect Concentrations (EECs) for the Chalk River Laboratories site; derived based on UNSCEAR (2008) - 100 µGy/h (2.4 mGy/d) for terrestrial organisms (Soil) and 400 µGy/h (9.6 mGy/d) for aquatic organisms (Water & Sediment).
EcoMetrix Inc. and Atomic Energy of Canada Limited (AECL). 2012. Environmental Risk Assessment Chalk River Laboratories - 2012. ENVP-509220-REPT-001, Rev. 0.

[orange] Environmental Media Concentrations (EMCs); derived based on incremental dose rate of 10 µGy/h for all ecosystems and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 40 to aquatic EMCs (Water and Sediment) and a factor of 10 to terrestrial EMCs (Soil).
ERICA Tool, updated June 4, 2019.

[green] No-Effect Concentrations (NECs), Upper Estimate, all ecosystems; derived based on UNSCEAR (1996) - 1 mGy/d for terrestrial biota and adjusted to be consistent with UNSCEAR (2008) by applying a factor of 2.4 (Soil).
SENES Consultants Limited. 2008. No-Effect Concentrations for Screening Assessment of Radiological Impacts on Non-Human Biota. Report prepared for NWMO. NWMO TR-2008-02.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 1996. Effects of Radiation on the Natural Environment. United Nations Scientific Committee on the Effects of Atomic Radiation. Vol. V92-53957.

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*. Annex E. Effects of Ionizing Radiation on Non-Human Biota.

Table 2-28 Summary of Radiological COPCs Selected for Inclusion in the EcoRA

Radionuclide COPCs		Comment
All Scenarios		
Ac-227 Mo-93 Nb-93m Pu-242 Th-229 U-233 Zr-93		These radionuclides 'screened-in' for all scenarios due to a lack of available screening criteria for all environmental media (surface water, soil and sediment).
(1a) NES Sensitivity Analysis - Inventory Sensitivity		
Ac-227 Mo-93 Nb-93m Pu-242 Th-229 U-233 Zr-93	Am-241 C-14 Cl-36 I-129 Po-210 Pu-239 Ra-226 Th-228	Because the sum of fractions for Perch Creek, Garden Area and Grazing Area was > 1, the top 5 radionuclides contributing to the activity in each aquatic and terrestrial system were also included in the assessment in addition to those radionuclides that 'screened-in' for all scenarios due to a lack of screening criteria.
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity		
Ac-227 Mo-93 Nb-93m Pu-242 Th-229 U-233 Zr-93	Am-241 C-14 Cl-36 Po-210 Pu-239 Ra-226 Th-228	Because the sum of fractions for Perch Creek and Grazing Area was > 1, the top 5 radionuclides contributing to the activity in each aquatic and terrestrial system were also included in the assessment in addition to those radionuclides that 'screened-in' for all scenarios due to a lack of screening criteria.
(15) What If - Human Intrusion, Mass Excavation and Farming		
Ac-227 Mo-93 Nb-93m Pu-242 Th-229 U-233 Zr-93	Am-241 C-14 Cl-36 Po-210 Pu-239 Ra-226 Th-228	In addition to those radionuclides that 'screened-in' for all scenarios due to a lack of screening criteria, C-14 and Po-210 also 'screened-in' because C-14 exceeded the surface water criterion in Perch Creek and Po-210 exceeded the sediment criterion in Perch Creek. Also, because the sum of fractions for Perch Creek, Garden Area and Grazing Area was > 1, the top 5 radionuclides contributing to the activity in these aquatic and terrestrial systems were also included in the assessment.

2.4.3 Non-radiological Constituents of Concern

2.4.3.1 Aluminum

If environmental criteria were not available for comparison in the screening process, then the incremental contaminant concentrations were compared to background concentrations. This is consistent with N288.6-12 guidance (CSA 2012), which states that if a contaminant is considered to be naturally elevated or if contaminant concentrations are within the range of local or regional concentrations, then the contaminant should be excluded from further consideration as a COPC. As shown in Table 2-30, environmental criteria are not available for aluminum in soil or sediment. Furthermore, aluminum is considered to be naturally elevated as it is the third most abundant element in the earth's crust.

As shown in Table 2-29, the maximum incremental aluminum concentrations predicted among all PostSA scenarios except scenarios (4) and (14), were less than 0.01% of the background aluminum concentration in each environmental medium. Thus, for these scenarios, the incremental aluminum concentrations in all environmental media are negligible compared to the background concentrations. For scenario (14), predicted aluminum concentrations in the surface waters of Perch Creek and the Ottawa River exceed the surface water criterion of 75 µg/L and are >100% of the background concentration. For scenario (4), the predicted aluminum concentration in surface water in Perch Creek is below the guideline value but is about 18% of the background concentration. Aluminum concentrations in soil were not predicted for scenarios (4) and (14). For the reasons noted here, aluminum was only carried through the EcoRA for scenarios (4) and (14) to assess exposure through aquatic pathways.

Table 2-29 Summary of Aluminum Concentrations in Environmental Media

Aluminum	Surface Water (µg/L) Perch Creek	Surface Water (µg/L) Ottawa River	Soil (mg/kg) Grazing Area	Soil (mg/kg) Garden Area	Sediment (mg/kg) Perch Creek	Sediment (mg/kg) Ottawa River
Environmental criteria from Table 2-30	75	75	NV	NV	NV	NV
Background concentration from Table 2-5	207	209	30,000	30,000	42	42
Maximum predicted incremental concentration of all post-closure scenarios (except scenarios 4 and 14)	0.02	0.00002	0	0.00003	0.00006	0
%incremental of background	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
Scenario (4)	37	0.05	N/A	N/A	0.000064	0
%incremental of background	18%	0.02%	-	-	0%	0%
Scenario (14)	327208	429	N/A	N/A	0.000064	0
%incremental of background	158,071%	205%	-	-	0%	0%

Notes: NV – no value, criterion not available.

2.4.3.2 Screening Procedure

With the exception of human intrusion scenarios, throughout the duration of the various post-closure scenarios assessed in the EcoRA, chemical contaminants are generally released directly into groundwater beneath the ECM, which in turn impacts the aquatic environment (sediment and surface water) downgradient of the NSDF site (Perch Creek) and further downstream (Ottawa River). Also, when bathtubbing occurs as part of the normal evolution process, the ECM fills up and overflows with water, which then flows to the downgradient Grazing Area where it infiltrates and contaminates the soil. The impacted soil in turn contaminates the surrounding air, fruits and vegetables grown on the soil, and animals grazing in the area. In the human intrusion scenarios biota are exposed to excavated contaminated soils that are dispersed in surface soils.

Table 2-30 Summary of Environmental Guidelines Considered in the COPC Screen

Contaminant	Surface Water		Soil	Sediment
	Perch Creek	Ottawa River	Grazing Area / Garden Area	Perch Creek / Ottawa River
	(µg/L)	(µg/L)	(mg/kg dw)	(mg/kg dw)
	CCME(1)	Quebec MELCC(7)	CCME(2)	CCME(3)
Aluminum	100	100	NV	NV
Copper	2	1.3	63	35.7
Lead	1	0.17	140	35.0
Uranium	15	14	23	NV
	Ontario MECP(4)	Ontario MECP(4)	Ontario MECP(5)	Ontario MECP(5)
Aluminum	75	75	NV	NV
Copper	5	-	92	16
Lead	1	-	120	31
Uranium	5	5	2.5	104.4(6)

Notes:

CCME – Canadian Council of Ministers of the Environment (on-line summary table of environmental quality guidelines accessed October 2019)

MECP – Ontario Ministry of the Environment, Conservation and Parks

MELCC – Quebec Ministère de l'Environnement et de la Lutte contre les changements climatiques

NV – no value available

(1) Water quality guidelines for the protection of freshwater aquatic life, long-term concentration; aluminum value for pH ≥6.5; copper and lead default values for hardness unknown.

(2) Soil quality guidelines for the protection of environmental and human health for residential/parkland use.

(3) Sediment quality guidelines for the protection of freshwater aquatic life, interim sediment quality guideline (ISQG).

(4) Provincial water quality objectives (OMOE 1994); aluminum for pH >6.5 to 9.0.

(5) Table 8 – Generic Site Condition Standards for Use within 30 m of a Water Body in Potable Groundwater Condition (OMOE 2011b); soil for residential/parkland/institutional/industrial/commercial/communityproperty use; groundwater and sediment for all types of property use.

(6) Lowest effect level (LEL) for uranium derived using weighted method in Table I of Thompson *et al.* (2005) applied to radionuclide releases to the environment from uranium mining and milling activities in Canada.

(7) Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC). 2020. *Surface Water Quality Criteria.* Retrieved from the MELCC webpage: http://www.environnement.gouv.qc.ca/eau/criteres_eau/index.asp; chronic aluminum criterion conservatively assumes pH=7.5, hardness=10 mg/L $CaCO_3$, and dissolved organic carbon (DOC)=0.1 mg/L; chronic copper and lead criteria are for a hardness of 10 mg/L $CaCO_3$; chronic uranium criterion is for a hardness of 20-100 mg/L $CaCO_3$.

For each post-closure scenario, maximum contaminant concentrations predicted over time (i.e., 10,000-year assessment period) in each environmental medium (i.e., soil in the Grazing Area between the NSDF and Perch Creek and the Garden Area on the ECM, and Perch Creek and Ottawa River sediment and surface water) were provided from the PostSA (Arcadis and Quintessa 2019). The maximum predicted environmental concentrations (i.e., incremental) were summed with the background concentrations presented in Table 2-5. The total environmental concentrations were then compared to the most conservative criterion for each medium in order to identify COPCs for inclusion in the EcoRA. Criteria from the Ontario Ministry of the Environment, Conservation and Parks (MECP) and Canadian Council of Ministers of the Environment (CCME) were the primary sources considered in the COPC screening exercise (Table 2-30). Because part of the Ottawa River within the expanded study area is located in the Province of Quebec, contaminant concentrations in Ottawa River surface water were also compared to Quebec surface water quality criteria from the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC 2020), which for some contaminants are more conservative than CCME and MECP. Sediment quality guidelines from Thompson *et al*. (2005) were also considered for uranium in sediment. A contaminant was ‘screened-in’ and assessed for a particular scenario if an exceedance of the respective criterion was noted in at least one environmental medium for that scenario and a toxicity reference value (TRV) was available. This screening approach is consistent with N288.6-12 (CSA 2012).

2.4.3.3 Screening Results

With respect to non-radiological contaminants, the post-closure assessment focused on the releases of aluminum, copper, lead and uranium. The total non-radionuclide environmental concentrations for each scenario (i.e., maximum predicted + background concentration), along with the screening decision, are summarized in Table 2-31. The screening process includes a comparison between total non-radionuclide concentrations and applicable criteria (most conservative of MECP and CCME, as well as MELCC for Ottawa River surface water). If a contaminant exceeded the screening criterion for at least one environmental medium then it was ‘screened-in’ (i.e., assessed) for that scenario.

As seen from Table 2-31, copper and lead ‘screened-in’ for assessment for all post-closure scenarios and uranium for all scenarios except scenario (13). Copper and lead total concentrations typically exceeded surface water and sediment criteria and were dominated by background levels. Uranium total concentrations typically exceeded the soil criterion and were dominated by incremental concentrations emitted from the NSDF Project. Aluminum ‘screened-in’ for scenarios (4) and (14) due to high total surface water concentrations.

The results of the COPC screen for non-radionuclides are summarized in Table 2-32.

Table 2-31 Total Non-Radionuclide Contaminant Concentrations (Maximum Predicted Incremental + Background) in Environmental Media Over 10,000 Year Post-closure Period and COPC Selection for All Scenarios

PostSA Scenario	Contaminant	Perch Creek Surface Water[1] (µg/L)	Ottawa River Surface Water (µg/L)	Garden Area Soil (mg/kg)	Grazing Area Soil (mg/kg)	Perch Creek Sediment (mg/kg)	Ottawa River Sediment (mg/kg)	Screen In?	Comment
Screening Criteria	Al	75	75	10000	10000	NV	NV		
	Cu	2	1.3	63	63	16	16		
	Pb	1	0.17	120	120	31	31		
	U	5	5	2.5	2.5	104.4	104.4		
Background Concentrations	Al	207	209	30000	30000	42	42		
	Cu	4.2	3	22	22	15	20		
	Pb	8	3	52	52	60	10		
	U	0.06	0	1.5	1.5	1	1.3		
(1) Normal Evolution Scenario and (9) Dose Optimization – Confidence in Land Use Restrictions	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.42E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.05E+01**	1.00E+01	**Yes**	
	U	2.19E-01	2.08E-16	1.50E+00	**3.70E+00**	1.22E+00	1.30E+00	**Yes**	
(1a) NES Sensitivity Analysis - Inventory Sensitivity	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.42E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.05E+01**	1.00E+01	**Yes**	
	U	3.85E-01	4.25E-04	1.50E+00	**5.97E+00**	1.46E+00	1.30E+00	**Yes**	
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.42E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.05E+01**	1.00E+01	**Yes**	
	U	2.19E-01	2.08E-04	1.50E+00	**3.70E+00**	1.22E+00	1.30E+00	**Yes**	
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.77E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.22E+01**	1.00E+01	**Yes**	
	U	4.42E-01	5.00E-04	1.50E+00	**5.97E+00**	1.52E+00	1.30E+00	**Yes**	
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.43E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.07E+01**	1.00E+01	**Yes**	
	U	2.23E-01	2.14E-04	1.50E+00	**3.70E+00**	1.22E+00	1.30E+00	**Yes**	
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.16E+00**	**3.00E+00**	5.20E+01	6.41E+01	**6.05E+01**	1.00E+01	**Yes**	
	U	2.17E-01	2.05E-04	1.50E+00	**3.37E+00**	1.23E+00	1.30E+00	**Yes**	
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.35E+00**	**3.00E+00**	5.20E+01	6.53E+01	**6.03E+01**	1.00E+01	**Yes**	
	U	2.04E-01	1.88E-04	1.50E+00	**3.59E+00**	1.21E+00	1.30E+00	**Yes**	
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.42E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.05E+01**	1.00E+01	**Yes**	
	U	2.19E-01	2.08E-04	1.70E+00	**3.70E+00**	1.22E+00	1.30E+00	**Yes**	
(4) Disruptive Event - Enhanced Erosion Case	Al	**2.44E+02**	**2.09E+02**	ND[2]	ND[2]	**4.20E+01**	**4.20E+01**	**Yes**	For aquatic receptors only
	Cu	**3.97E+01**	**3.05E+00**	ND	**1.80E+03**	1.56E+01	**2.00E+01**	**Yes**	Not assessed for terrestrial receptors in the Garden Area
	Pb	**1.03E+01**	**3.00E+00**	ND	**1.31E+02**	**6.16E+01**	1.00E+01	**Yes**	
	U	2.57E-01	2.58E-04	ND	**2.93E+00**	1.25E+00	1.30E+00	**Yes**	
(5) Disruptive Event - Localized Cover Failure	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.43E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.06E+01**	1.00E+01	**Yes**	
	U	2.18E-01	2.07E-04	1.50E+00	**3.67E+00**	1.22E+00	1.30E+00	**Yes**	
(6) Disruptive Event - Localized Liner Failure	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.30E+00**	**3.00E+00**	5.20E+01	6.43E+01	**6.06E+01**	1.00E+01	**Yes**	
	U	2.51E-01	2.50E-04	1.50E+00	**3.43E+00**	1.27E+00	1.30E+00	**Yes**	

PostSA Scenario	Contaminant	Perch Creek Surface Water[1] (µg/L)	Ottawa River Surface Water (µg/L)	Garden Area Soil (mg/kg)	Grazing Area Soil (mg/kg)	Perch Creek Sediment (mg/kg)	Ottawa River Sediment (mg/kg)	Screen In?	Comment
Screening Criteria	Al	75	75	10000	10000	NV	NV		
	Cu	2	1.3	63	63	16	16		
	Pb	1	0.17	120	120	31	31		
	U	5	5	2.5	2.5	104.4	104.4		
Background Concentrations	Al	207	209	30000	30000	42	42		
	Cu	4.2	3	22	22	15	20		
	Pb	8	3	52	52	60	10		
	U	0.06	0	1.5	1.5	1	1.3		
(7) Disruptive Event - Damage to Berm	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.47E+00**	**3.00E+00**	5.20E+01	6.66E+01	**6.06E+01**	1.00E+01	**Yes**	
	U	2.12E-01	1.99E-04	1.50E+00	**4.13E+00**	1.21E+00	1.30E+00	**Yes**	
(8) Dose Optimization - Wastes Grouted into Steel Liners	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.42E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.05E+01**	1.00E+01	**Yes**	
	U	2.08E-01	1.94E-04	1.50E+00	**3.70E+00**	1.21E+00	1.30E+00	**Yes**	
(11) Defence-in-Depth - Role of Geosphere	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.89E+00**	**3.00E+00**	5.20E+01	6.60E+01	**6.19E+01**	1.00E+01	**Yes**	
	U	2.27E-01	2.19E-04	1.50E+00	**3.70E+00**	1.25E+00	1.30E+00	**Yes**	
(12) Defence-in-Depth - Role of Cover	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.45E+00**	**3.00E+00**	5.20E+01	6.64E+01	**6.06E+01**	1.00E+01	**Yes**	
	U	2.20E-01	2.10E-04	1.50E+00	**3.78E+00**	1.22E+00	1.30E+00	**Yes**	
(13) Defence-in-Depth - Role of Base Liner	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.26E+00**	**3.00E+00**	5.20E+01	5.20E+01	**6.08E+01**	1.00E+01	**Yes**	
	U	2.53E-01	2.53E-04	1.50E+00	1.50E+00	1.28E+00	1.30E+00		
(14) Defence-in-Depth - Series of Landslides	Al	**3.27E+05**	**6.38E+02**	ND[2]	ND[2]	**4.20E+01**	**4.20E+01**	**Yes**	For aquatic receptors only
	Cu	**2.05E+02**	**3.29E+00**	ND	**5.61E+03**	**2.00E+01**	**2.02E+01**	**Yes**	Not assessed for terrestrial receptors in the Garden Area
	Pb	**1.89E+01**	**3.01E+00**	ND	**1.53E+02**	**6.38E+01**	1.00E+01	**Yes**	
	U	5.48E-01	6.46E-04	ND	**5.57E+00**	1.21E+00	1.30E+00	**Yes**	
(15) What If - Human Intrusion, Mass Excavation and Farming	Cu	**4.20E+00**	**3.00E+00**	**1.19E+03**	**1.11E+03**	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**9.72E+00**	**3.00E+00**	1.11E+02	1.03E+02	**6.50E+01**	1.00E+01	**Yes**	
	U	3.75E-01	4.13E-04	**4.77E+00**	**6.27E+00**	1.46E+00	1.30E+00	**Yes**	
(17) What If - Permanent Bathtub	Cu	**4.20E+00**	**3.00E+00**	2.20E+01	2.20E+01	1.50E+01	**2.00E+01**	**Yes**	
	Pb	**8.90E+00**	**3.00E+00**	5.20E+01	6.66E+01	**6.17E+01**	1.00E+01	**Yes**	
	U	1.89E-01	1.69E-04	1.50E+00	**3.78E+00**	1.15E+00	1.30E+00	**Yes**	

Notes:

(1) For Scenarios (4) and (14) - Waste materials move downslope into the creek forming suspended sediment. Solubility limits are not applied in the creek, therefore dissolution of contaminants from the suspended sediment and contaminant concentrations in the creek water are likely to be overestimated.

(2) A very high inventory derived based on an estimated number of packages was used for Al, with releases from the ECM in water being solubility limited. The concentration in the swamp soils due to landslides and downslope movement of the wastes depends on the very high inventory and therefore the result is meaningless.

ND – not determined.

Table 2-32 Summary of Non-Radiological COPCs Selected for Inclusion in the EcoRA

Scenario	Non-Radionuclide COPCs	Comment
(1) Normal Evolution Scenario (NES) (1a) NES Sensitivity Analysis - Inventory Sensitivity (1b) NES Sensitivity Analysis - Institutional Control Sensitivity (1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity (1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek (1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner (1f) NES Sensitivity Analysis - Global Warming - Reduced HER (3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic) (4) Disruptive Event - Enhanced Erosion Case (5) Disruptive Event - Localized Cover Failure (6) Disruptive Event - Localized Liner Failure (7) Disruptive Event - Damage to Berm (8) Dose Optimization - Wastes Grouted into Steel Liners (10) Dose Optimization - Confidence in Land Use Restrictions (same as NES) (12) Defence-in-Depth - Role of Geosphere (13) Defence-in-Depth - Role of Cover (14) Defence-in-Depth - Role of Base Liner (15) Defence-in-Depth - Series of Landslides (16) What If - Human Intrusion, Mass Excavation and Farming (17) What If - Permanent Bathtub	Al	'Screened-in' for scenarios (4) and (14) because the surface water criterion was exceeded in Perch Creek and Ottawa River; there are no screening criteria for soil and sediment; total aluminum concentrations in the remaining scenarios are completely dominated by background levels and for this reason, aluminum is not carried through the EcoRA for the remaining scenarios.
	Cu	'Screened-in' for all scenarios because the surface water criterion was exceeded in Perch Creek and Ottawa River and the sediment criterion in Ottawa River; the soil criterion was also exceeded in the Grazing Area in scenarios (4), (14) and (15) and in the Garden Area in scenario (15); total concentrations are dominated by background levels in most media and scenarios.
	Pb	'Screened-in' for all scenarios because the surface water criterion was exceeded in Perch Creek and Ottawa River and the sediment criterion in Perch Creek; the soil criterion was also exceeded in the Grazing Area in scenarios (4) and (14); total concentrations are dominated by background levels in most media and scenarios.
	U	With the exception of scenario (13), 'screened-in' for all scenarios because the soil criterion was exceeded in the Grazing Area as well as in the Garden Area in scenario (15); total concentrations are dominated by incremental concentrations from the NSDF Project in Perch Creek surface water and soil in the Grazing Area in most scenarios.

2.5 Exposure Pathways

The active exposure pathways of radiological and non-radiological COPCs for the ecological receptors identified in Section 2.2.1 are presented in Table 2-33 and Table 2-34, respectively. The exposure pathways are based on the known habitat needs, mobility, and diets of the ecological receptors, along with knowledge of the location of their respective habitats within the study area.

Terrestrial vegetation and terrestrial invertebrates (earthworms) are directly exposed to contaminated soil and are thus assessed against contaminant concentrations in soil. Consequently, pathways of exposure (e.g., ingestion, inhalation, etc.) are not explicitly modelled (or needed) for these receptors.

Similarly, aquatic vegetation, benthic invertebrates, benthic and pelagic fish, and tadpole (frog) are directly exposed to contaminated surface water and sediment are thus assessed against contaminant concentrations in surface water and sediment. As such, pathways of exposure (e.g., ingestion, inhalation, etc.) are not explicitly modelled (or needed) for these receptors.

Terrestrial mammals and birds are exposed through ingestion of food, including terrestrial vegetation, insects (i.e., invertebrates) and earthworms, as well as incidental ingestion of soil and surface water. Higher trophic species (such as the bald eagle, eastern wolf and black bear) will also consume lower trophic species (such as fish, voles and shrews), as part of their diet. It is assumed that terrestrial mammals and birds obtain all of their food from the site or specific exposure area within the site (e.g., Grazing Area or Garden Area), which is very conservative given that many species have larger home ranges or forage areas than provided by the site or localized exposure area.

Aquatic birds are exposed through ingestion of food, including aquatic vegetation and benthic invertebrates, as well as ingestion of sediment and surface water. Higher trophic species (such as the belted kingfisher, mallard and great blue heron) consume fish as part of their diet.

The following pathways have been identified as inactive, or are otherwise not applicable:

- Inhalation; and,
- Dermal uptake.

As discussed in CSA N288.6-12 (2012), inhalation exposures are typically minor in relation to soil and food ingestion exposures and can therefore be excluded from assessments. For particulate substances released to air and accumulation in the soil over time, the steady-state soil concentrations are usually high enough that soil and food ingestion components of dose are dominant.

Dermal exposure is generally not a significant pathway of exposure for wildlife as fur and feathers are effective at blocking direct contact with skin. Water, diet items, and incidental ingestion of soil and sediment are usually by far the most important pathways of exposure for wildlife and inclusion of dermal exposure and inhalation pathways is rarely necessary (Environment Canada 2012a).

Table 2-33 Summary of Exposure Pathways for Radiological Contaminants

Receptor	Environmental Media Exposed	Modes of Exposure to Radiological COPCs	Risk Calculation Method
			Radiation
Aquatic Vegetation (Reed)	• surface water	• uptake from surface water • immersion in surface water	• internal dose from surface water • external dose from surface water
Pelagic Invertebrates (Zooplankton)	• surface water	• uptake from surface water • immersion in surface water	• internal dose from surface water • external dose from surface water
Benthic Invertebrates and Amphibians (Green Frog - tadpole)	• surface water • sediment	• uptake from surface water • immersion in surface water • immersion in sediment	• internal dose from surface water • external dose from surface water (50%) • external dose from sediment (50%)
Pelagic Fish (Northern Pike) and Benthic Fish (Bluntnose Minnow and Brown Bullhead)	• surface water • sediment	**Pelagic fish:** • uptake from surface water • immersion in surface water **Benthic fish:** • uptake from surface water • immersion in surface water • exposure to sediment	**Pelagic fish:** • internal dose from surface water • external dose from surface water **Benthic fish:** • internal dose from surface water • external dose from surface water (50%) • external dose from sediment (50%)
Aquatic Birds (Belted Kingfisher, Great Blue Heron and Mallard)	• surface water • sediment	• ingestion (as appropriate): - surface water (all) - sediment (all) - fish (all) - benthic invertebrates (Great Blue Heron, Mallard) - terrestrial invertebrates/insects (Mallard) - aquatic & terrestrial vegetation (Mallard) - small mammals, i.e., shrew and vole (Great Blue Heron) • immersion in surface water (all)	• internal dose from ingestion • external dose from surface water
Aquatic Reptiles (Snapping Turtle)	• surface water • sediment	• ingestion - surface water - sediment - fish - aquatic vegetation • immersion in surface water • exposure to sediment	• internal dose from ingestion • external dose from surface water (50%) • external dose from sediment (50%)
Aquatic Mammals (Moose)	• surface water • sediment	• ingestion: - surface water	• internal dose from ingestion • external dose from sediment

Receptor	Environmental Media Exposed	Modes of Exposure to Radiological COPCs	Risk Calculation Method
			Radiation
		- sediment - aquatic vegetation - terrestrial vegetation	
Terrestrial Invertebrates (Earthworm)	• soil	• uptake from soil • immersion in soil	• internal dose from soil • external dose from soil
Terrestrial Plants (Red Maple)	• soil	• uptake from soil (root uptake) • exposure to soil	• internal dose from soil • external dose from soil
Terrestrial Birds (Bald Eagle, Canada Warbler, Eastern Whip-poor-will, Purple Finch and Ruffed Grouse)	• surface water • soil	• ingestion (as appropriate): - surface water (all) - soil (all) - seeds or fruit (Purple Finch) - terrestrial vegetation (Ruffed Grouse) - terrestrial invertebrates/insects (Canada Warbler, Eastern Whip-poor-will, Ruffed Grouse) - small mammals (i.e., shrew and vole) and birds (i.e., warbler, whip-poor-will, finch, grouse) (Bald Eagle) - fish (Bald Eagle) • direct exposure to soil (all)	• internal dose from ingestion • external dose from soil
Terrestrial Mammals (Black Bear, Eastern Wolf, Little Brown Myotis, Meadow Vole, Short-tailed Shrew, White-tailed Deer)	• surface water • soil	• ingestion (as appropriate): - surface water (all) - soil (all) - terrestrial invertebrates/insects (Black Bear, Little Brown Myotis, Short-tailed Shrew) - terrestrial vegetation (Black Bear, Meadow Vole, White-tailed Deer) - small mammals (i.e., vole and shrew) (Black Bear, Eastern Wolf) - deer (Eastern Wolf) - fish (Black Bear) - aquatic & terrestrial invertebrates/insects (Little Brown Myotis) • direct exposure to soil (all)	• internal dose from ingestion • external dose from soil

Note: The monarch butterfly, common watersnake and eastern milksnake are not included in the table as they were assessed qualitatively.

Table 2-34 Summary of Exposure Pathways for Non-Radiological Contaminants

Receptor	Environmental Media Exposed	Modes of Exposure to Non-radiological COPC	Risk Calculation Method
			Non-Radioactive
Aquatic Vegetation (Reed)	• surface water	• uptake from surface water	Comparison of surface water concentrations with benchmark values.
Pelagic Invertebrates (Zooplankton)	• surface water	• uptake from surface water	Comparison of surface water concentrations with benchmark values.
Benthic Invertebrates and Amphibians (Green Frog – tadpole)	• surface water	• uptake from surface water	Comparison of surface water concentrations with benchmark values.
Pelagic (Northern Pike) and *Benthic Fish (Bluntnose Minnow and Brown Bullhead)*	• surface water	• uptake from surface water	Comparison of surface water concentrations with corresponding benchmark values.
Aquatic Birds (Belted Kingfisher, Great Blue Heron and Mallard)	• surface water • sediment	• ingestion (as appropriate): - surface water (all) - sediment (all) - fish (fish) - benthic invertebrates (Great Blue Heron, Mallard) - terrestrial invertebrates/insects (Mallard) - aquatic & terrestrial vegetation (Mallard) - small mammals, i.e. shrew and vole (Great Blue Heron)	Comparison of dose from intake with benchmark values.
Aquatic Mammals (Moose)	• surface water • sediment	• ingestion: - surface water - sediment - aquatic vegetation - terrestrial vegetation	Comparison of dose from intake with benchmark values.
Terrestrial Invertebrates (Earthworm)	• soil • groundwater	• uptake from soil • uptake from groundwater	Comparison of soil or groundwater concentrations with benchmark values.
Terrestrial Plants (Red Maple)	• soil	• uptake from soil (root uptake)	Comparison of soil concentrations with benchmark values.

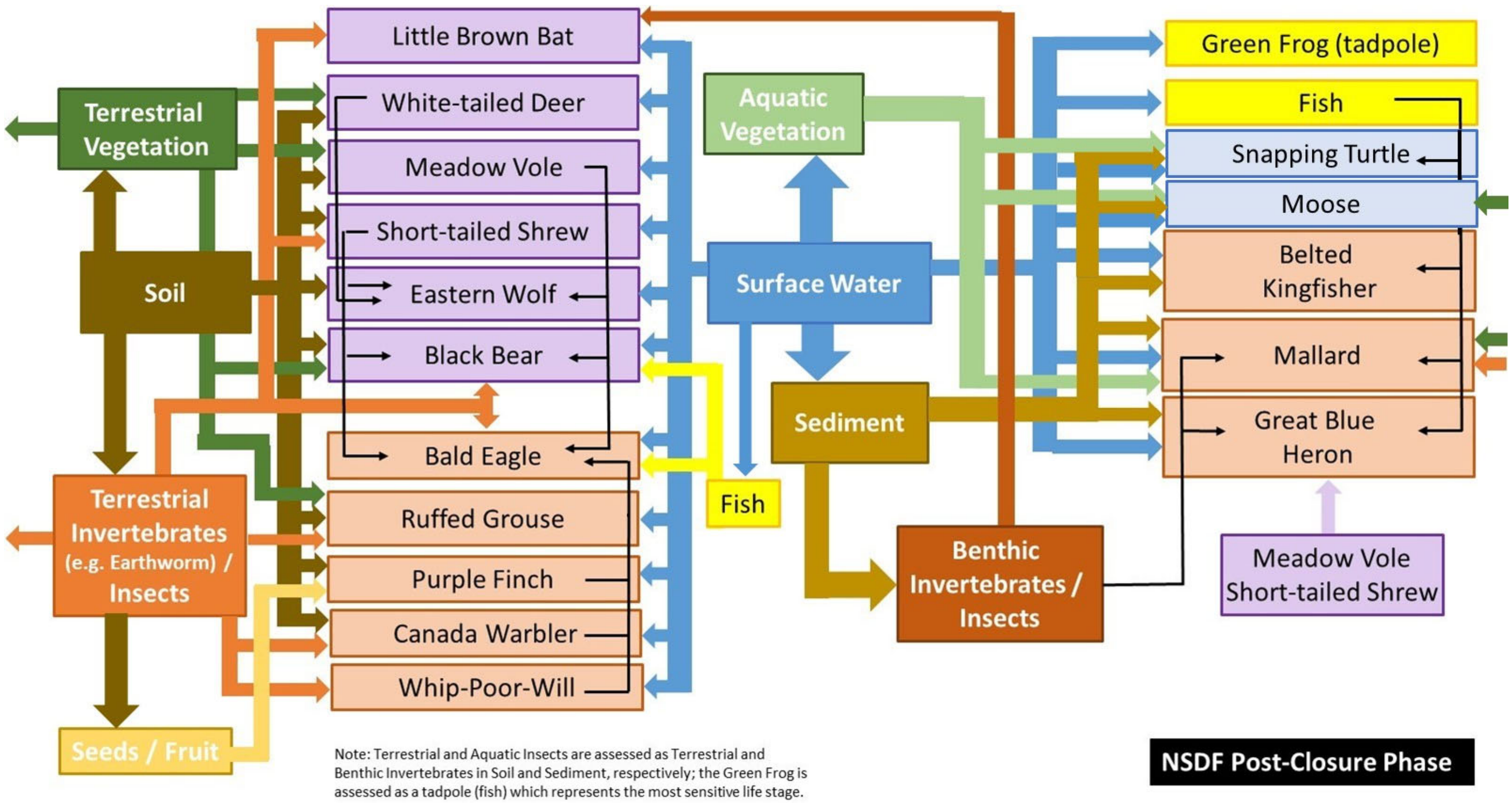
Receptor	Environmental Media Exposed	Modes of Exposure to Non-radiological COPC	Risk Calculation Method
			Non-Radioactive
Terrestrial Birds (Bald Eagle, Canada Warbler, Eastern Whip-poor-will, Purple Finch and Ruffed Grouse)	• surface water • soil	• ingestion: - surface water (all) - soil (all) - seeds or fruit (Purple Finch) - terrestrial vegetation (Ruffed Grouse) - terrestrial invertebrates/insects (Canada Warbler, Eastern Whip-poor-will, Ruffed Grouse) - small mammals (i.e., shrew vole and shrew) and birds (i.e., warbler, whip-poor-will, finch, grouse) (Bald Eagle) - fish (Bald Eagle)	Comparison of dose from intake with benchmark values.
Terrestrial Mammals (Black Bear, Eastern Wolf, Little Brown Myotis, Meadow Vole, Short-tailed Shrew, White-tailed Deer)	• surface water • soil	• ingestion (as appropriate): - surface water (all) - soil (all) - terrestrial invertebrates/insects (Black Bear, Little Brown Myotis, Short-tailed Shrew) - terrestrial vegetation (Black Bear, Meadow Vole, White-tailed Deer) - small mammals (i.e., vole and shrew) (Black Bear, Eastern Wolf) - fish (Black Bear) - aquatic & terrestrial invertebrates/insects (Little Brown Myotis)	Comparison of dose from intake with benchmark values.

Note: The monarch butterfly, common watersnake, eastern milksnake and snapping turtle are not included in the table as they were assessed qualitatively.

2.6 Conceptual Site Model

While a number of different scenarios were considered in the EcoRA, the underlying conceptual model for each scenario was generally the same as that for the Normal Evolution Scenario, but the selection of scenario-related parameters affecting the predictions differed. Figure 2-3 presents a schematic conceptual site model based on the identified ecological receptors and the relevant exposure pathways.

Figure 2-3 Conceptual Site Model for the Post-closure Phase for All Scenarios



3 EXPOSURE ASSESSMENT

3.1 Exposure Points

The PostSA (Arcadis and Quintessa 2019) predicted radiological and non-radiological contaminant concentrations over time (i.e., 10,000-year assessment timeframe) in all relevant environmental media (i.e., surface water and sediment in Perch Creek and Ottawa River and soil in Grazing Area and Garden Area) for each scenario that was assessed. The maximum COPC concentrations that were predicted over the entire assessment timeframe in each environmental medium for each scenario with added background for non-radiological contaminants were used as exposure point concentrations (EPCs) in the EcoRA. In this way, for each scenario assessed, a receptor is hypothetically/mathematically exposed to the worst-case concentrations in several environmental media simultaneously, regardless of when the peak occurred in each environmental medium. The use of maximum COPC concentrations regardless of time of peak is a conservative approach.

3.2 Exposure Factors for Receptors

Table 3-1 presents an overview of key exposure factors among the ecological receptors identified and described in Section 2.2.1. Detailed species-specific information and descriptions are presented in Appendix A (ecological profiles).

The exposure factors for ecological receptors were preferentially obtained from Module C (*Standardization of Wildlife Receptor Characteristics*) of the Environment Canada (2012b) *Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance*.

Soil and sediment ingestion rates, if not available in the FCSAP (Environment Canada 2012b) document, were obtained from a wildlife soil ingestion study completed by Beyer *et al.* (1994) who estimated the fractional soil composition of the diets (i.e., percentage of the dry weight food ingestion rate) of 28 wildlife species.

When food and water intake rates were not available directly from the above-mentioned sources, the following allometric equations from the U.S. Environmental Protection Agency (U.S. EPA 1993) were used:

Dry weight food Ingestion (g dw/d):

$$Birds = 0.648 * BW^{0.651} \quad (3\text{-}1)$$

$$Mammals = 0.235 * BW^{0.822} \quad (3\text{-}2)$$

where

BW = Body Weight [in g].

Water Intake (L/d):

$$Birds = 0.059 * BW^{0.67} \quad (3\text{-}3)$$

$$Mammals = 0.099 * \mathrm{BW}^{0.9} \quad (3\text{-}4)$$

where

BW = Body Weight [in kg].

Other sources were also consulted to infill information mainly on body weights and dietary characteristics for the eastern wolf (Schmidt and Gilbert 1987; Fuller and Keith 1980; Smith 2002), little brown myotis (Havens 2006), short-tailed shrew (MOE 2011a) and birds including the belted kingfisher, eastern whip-poor-will and purple finch (Cornell 2017).

For this assessment, the fraction of time spent on-site consuming food and water was assumed to be 1 for all receptors regardless of their migratory patterns or home ranges. This is a very conservative assumption as many bird species (e.g., great blue heron, mallard) migrate to southern destinations for the winter, large mammals (e.g., black bear, bald eagle) have home ranges much larger than the area of the NSDF site, while other species hibernate in the winter time (e.g., little brown myotis, snapping turtle).

Table 3-1 Overview of Exposure Factors for Ecological Receptors

Parameter	Ecological Receptor [a, b]																															
	Bald Eagle		Belted Kingfisher		Black Bear		Canada Warbler		Eastern Whip-poor-will		Eastern Wolf		Great Blue Heron		Little Brown Myotis		Mallard		Meadow Vole		Moose		Purple Finch		Ruffed Grouse		Short-tailed Shrew		Snapping Turtle		White-tailed Deer	
	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref	Value	Ref
Body Weight (kg)	4.7	(1)	0.155	(9)	68	(1)	0.011	(9)	0.053	(9)	43	(4)	2.3	(1)	0.0095	(7)	1.2	(1)	0.0349	(1)	400	(1)	0.024	(9)	0.552	(1)	0.015	(8)	7.9	(2)	75	(1)
Water Intake Rate (L/d)	0.188	(1)	0.017	(2)	4.08	(1)	0.003	(2)	0.008	(2)	2.92	(2)	0.092	(1)	0.0015	(2)	0.072	(1)	0.007	(1)	20	(1)	0.005	(2)	0.0386	(1)	0.00226	(2)	0.158	(2)	4.5	(1)
Soil Ingestion Rate (g(dw)/d)	5.91	(3)	-	-	81.6	(3)	0.322	(3)	Negligible	(9)	49.3	(3)	-	-	Negligible	-	-	-	0.083	(1)	-	-	0.474	(3)	3.3	(3)	0.187	(8)	-	-	45	(1)
Sediment Ingestion Rate (g(dw)/d)	-	-	0.388	(3)	-	-	-	-	-	-	-	-	2.07	(3)	-	-	1.98	(1)	-	-	160	(1)	-	-	-	-	-	-	1.87	(3)	-	-
Food Ingestion Rate (g(ww)/d)	564	(1)	77.5	(2)	6800	(1)	8.8	(2)	24.6	(2)	5500	(5)	414	(1)	6	(2)	300	(1)	11.5	(1)	53333	(1)	5.6	(2)	125	(1)	9	(8)	180	(2)	7500	(1)
Fraction that is fish	0.65	(1)	1	(9)	0.05	(1)	-	-	-	-	-	-	0.65	(1)	-	-	0.025	(1)	-	-	-	-	-	-	-	-	-	-	0.6	(2)	-	-
Fraction that is benthic invertebrates/ insects [c]	-	-	-	-	-	-	-	-	-	-	-	-	0.1	(1)	0.5	(7)	0.4	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraction that is aquatic vegetation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	(1)	-	-	0.2	(1)	-	-	-	-	-	-	0.4	(2)	-	-
Fraction that is small mammals	0.2	(1)	-	-	0.1	(1)	-	-	-	-	0.8	(6)	0.25	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraction that is deer	-	-	-	-	-	-	-	-	-	-	0.2	(6)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraction that is birds	0.15	(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fraction that is soil invertebrates/ insects [c]	-	-	-	-	0.05	(1)	1	(9)	1	(9)	-	-	-	-	0.5	(7)	0.025	(1)	-	-	-	-	-	-	0.15	(1)	1	(8)	-	-	-	-
Fraction that is terrestrial vegetation	-	-	-	-	0.8	(1)	-	-	-	-	-	-	-	-	-	-	0.05	(1)	1	(1)	0.8	(1)	-	-	0.85	(1)	-	-	-	-	1	(1)
Fraction that is seeds/fruit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	(9)	-	-	-	-	-	-	-	-
Fraction of time at site	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-

Notes:

(a) Exposure factors for the green frog are not included in Table 3-1 because it was assessed as a fish, directly against environmental COPC concentrations, to represent the most sensitive early life stage of the frog (tadpole).

(b) Exposure factors for the monarch butterfly, common watersnake, and eastern milksnake are not included in Table 3-1 because they were assessed qualitatively.

(c) Flying insects and insects on surface water are represented by soil invertebrates and benthic invertebrates, respectively.

(d) Small mammals are represented by the short-tailed shrew and meadow vole.

References:

(1) Environment Canada (FCSAP) (2012b)
(2) U.S. EPA (1993)
(3) Beyer *et al.* (1994)
(4) Schmidt and Gilbert (1978)
(5) Fuller and Keith (1980)
(6) Assumed based on Smith (2002)
(7) Havens (2006)
(8) MOE (2011a)
(9) Cornell (2017)

3.3 Exposure Durations and Averaging

It has been conservatively assumed that all aquatic and terrestrial ecological receptors spend their entire exposure duration within their exposure locations. In other words, there is no reduction to account for time spent outside of the exposure location.

For migratory species, risk calculations do *not* average a receptor's exposure based on time away from the site during migration.

3.4 Exposure Point Concentrations

Sections 2.2.4, 2.5, and 2.6 discuss the locations of ecological receptors, the environmental media that each receptor can be exposed to, and the pathways through which they can potentially be exposed.

The following tables present the contaminant concentrations in each environmental medium that are relevant to the identified receptors and pathways. Transfer factors (Table 3-10 and Table 3-11) were used to estimate COPC concentrations in fish flesh, aquatic and terrestrial vegetation, benthic invertebrates, earthworms, seeds, birds and mammals that are consumed by receptors.

Table 3-2, Table 3-3 and Table 3-4 present the radiological EPCs while Table 3-5, Table 3-6 and Table 3-7 present the non-radiological EPCs.

Table 3-2 Exposure Point Concentrations of Radiological COPCs in Environmental Media

Radiological COPCs	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediments (Bq/kg)	Ottawa River Sediment (Bq/kg)
(1) Normal Evolution Scenario and (9) Dose Optimization - Confidence in Land Use Restrictions						
Ac227	1.87E-05	2.45E-08	0.00E+00	1.56E-02	1.07E-02	3.89E-06
Mo93	3.85E-08	5.04E-11	0.00E+00	3.57E-04	7.90E-05	3.89E-09
Nb93m	5.86E-04	7.68E-07	0.00E+00	5.71E+02	9.85E+00	1.64E-03
Pu242	1.60E-05	2.09E-08	0.00E+00	1.83E-02	7.25E-01	3.34E-05
Th229	9.97E-09	1.31E-11	0.00E+00	8.33E-02	1.43E-02	2.40E-06
U233	6.74E-06	8.83E-09	0.00E+00	1.02E-01	9.36E-03	4.32E-07
Zr93	1.36E-03	1.78E-06	0.00E+00	5.70E+02	3.59E+01	1.71E-03
(1a) NES Sensitivity Analysis - Inventory Sensitivity						
Ac227	7.75E-05	1.01E-07	0.00E+00	1.52E-01	3.10E-02	1.18E-05
Am241	2.54E-02	3.33E-05	0.00E+00	5.70E+01	4.67E+02	2.39E-02
C14	8.18E-01	1.06E-03	1.70E+02	1.70E+01	1.52E+03	4.95E-02
Cl36	6.21E-02	8.13E-05	0.00E+00	2.63E-01	3.70E+01	9.85E-04
I129	3.45E-01	4.52E-04	0.00E+00	2.41E+02	3.35E+04	1.21E+00
Mo93	3.85E-07	5.04E-10	0.00E+00	3.57E-03	7.90E-04	3.89E-08
Nb93m	5.86E-03	7.68E-06	0.00E+00	5.71E+03	9.85E+01	1.64E-02
Po210	2.30E-02	2.98E-05	0.00E+00	1.22E+02	4.39E-01	8.92E-04
Pu239	2.18E-01	2.86E-04	0.00E+00	2.42E+02	9.91E+03	4.54E-01
Pu242	1.60E-04	2.09E-07	0.00E+00	1.83E-01	7.25E+00	3.34E-04
Ra226	1.14E-04	1.50E-07	0.00E+00	1.48E+02	4.39E+00	1.02E-03
Th228	5.36E-07	7.10E-10	0.00E+00	1.47E+02	1.29E-01	1.24E-04
Th229	2.07E-08	2.71E-11	0.00E+00	2.57E-01	2.96E-02	4.98E-06
U233	1.43E-05	1.87E-08	0.00E+00	2.06E-01	1.95E-02	9.26E-07
Zr93	1.36E-02	1.78E-05	0.00E+00	5.70E+03	3.59E+02	1.71E-02
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity						
Ac227	1.87E-05	2.45E-08	0.00E+00	1.56E-02	1.07E-02	3.89E-06
Mo93	3.85E-08	5.04E-11	0.00E+00	3.57E-04	7.90E-05	3.89E-09
Nb93m	5.86E-04	7.68E-07	0.00E+00	5.71E+02	9.85E+00	1.64E-03
Pu242	1.60E-05	2.09E-08	0.00E+00	1.83E-02	7.25E-01	3.34E-05
Th229	9.97E-09	1.31E-11	0.00E+00	8.33E-02	1.43E-02	2.40E-06
U233	6.74E-06	8.83E-09	0.00E+00	1.02E-01	9.36E-03	4.32E-07
Zr93	1.36E-03	1.78E-06	0.00E+00	5.70E+02	3.59E+01	1.71E-03
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity						
Ac227	7.34E-05	9.61E-08	0.00E+00	8.70E-02	4.13E-02	1.41E-05
Am241	2.40E-02	3.14E-05	0.00E+00	1.17E+01	9.53E+02	3.54E-02
C14	4.31E-01	5.57E-04	1.70E+01	4.22E+00	8.35E+02	1.97E-02
Cl36	8.64E-03	1.13E-05	0.00E+00	1.07E-02	7.26E+00	1.27E-04
Mo93	1.08E-07	1.41E-10	0.00E+00	5.80E-04	3.87E-04	1.09E-08
Nb93m	6.22E-03	8.15E-06	0.00E+00	4.00E+03	2.39E+02	3.81E-02
Po210	1.90E-02	2.46E-05	0.00E+00	9.94E+01	3.81E-01	7.02E-04
Pu239	5.63E-02	7.37E-05	0.00E+00	3.82E+01	2.98E+03	9.03E-02
Pu242	4.11E-05	5.38E-08	0.00E+00	2.86E-02	2.18E+00	6.62E-05
Ra226	8.98E-05	1.18E-07	0.00E+00	1.22E+02	3.94E+00	8.02E-04
Th228	5.36E-07	7.11E-10	0.00E+00	1.47E+02	1.29E-01	1.24E-04
Th229	2.80E-08	3.66E-11	0.00E+00	2.37E-01	4.16E-02	6.78E-06
Th232	5.31E-07	6.95E-10	0.00E+00	1.47E+02	1.32E-01	1.25E-04

Radiological COPCs	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediments (Bq/kg)	Ottawa River Sediment (Bq/kg)
U233	1.64E-05	2.15E-08	0.00E+00	2.06E-01	2.28E-02	1.06E-06
U234	4.25E-03	5.56E-06	0.00E+00	5.08E+01	5.91E+00	2.74E-04
Zr93	3.16E-02	4.14E-05	0.00E+00	4.00E+03	8.66E+02	4.10E-02
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek						
Ac227	1.96E-05	2.57E-08	0.00E+00	1.56E-02	1.12E-02	4.10E-06
Mo93	4.22E-08	5.53E-11	0.00E+00	3.57E-04	8.87E-05	4.13E-09
Nb93m	5.88E-04	7.71E-07	0.00E+00	5.71E+02	9.89E+00	1.66E-03
Pu242	1.73E-05	2.27E-08	0.00E+00	1.83E-02	7.99E-01	3.57E-05
Th229	1.03E-08	1.35E-11	0.00E+00	8.33E-02	1.49E-02	2.48E-06
U233	6.96E-06	9.11E-09	0.00E+00	1.02E-01	9.50E-03	4.47E-07
Zr93	1.33E-03	1.74E-06	0.00E+00	5.70E+02	3.54E+01	1.75E-03
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner						
Ac227	1.91E-05	2.50E-08	0.00E+00	3.25E-03	1.12E-02	3.90E-06
Mo93	3.56E-08	4.66E-11	0.00E+00	3.77E-04	7.55E-05	3.66E-09
Nb93m	2.62E-04	3.44E-07	0.00E+00	2.57E+02	7.37E+00	1.24E-03
Pu242	2.83E-05	3.71E-08	0.00E+00	5.55E-03	1.14E+00	5.07E-05
Th229	9.60E-09	1.26E-11	0.00E+00	1.15E-02	1.55E-02	2.30E-06
U233	6.60E-06	8.65E-09	0.00E+00	8.68E-02	9.65E-03	4.32E-07
Zr93	1.02E-03	1.34E-06	0.00E+00	2.56E+02	2.69E+01	1.32E-03
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER						
Ac227	1.72E-05	2.25E-08	0.00E+00	1.47E-02	9.61E-03	3.50E-06
Mo93	3.36E-08	4.40E-11	0.00E+00	3.42E-04	7.58E-05	3.63E-09
Nb93m	4.09E-04	5.36E-07	0.00E+00	4.56E+02	8.10E+00	1.29E-03
Pu242	1.32E-05	1.73E-08	0.00E+00	1.77E-02	6.27E-01	3.61E-05
Th229	9.01E-09	1.18E-11	0.00E+00	5.30E-02	1.14E-02	2.16E-06
U233	5.98E-06	7.84E-09	0.00E+00	9.67E-02	8.73E-03	3.89E-07
Zr93	1.03E-03	1.35E-06	0.00E+00	4.56E+02	2.69E+01	1.33E-03
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)						
Ac227	1.87E-05	2.45E-08	5.82E-04	1.56E-02	1.07E-02	3.89E-06
Mo93	3.85E-08	5.04E-11	4.84E-06	3.57E-04	7.90E-05	3.89E-09
Nb93m	5.86E-04	7.68E-07	1.67E+01	5.71E+02	9.85E+00	1.64E-03
Pu242	1.60E-05	2.09E-08	2.25E-03	1.83E-02	7.25E-01	3.34E-05
Th229	9.97E-09	1.31E-11	6.02E-04	8.33E-02	1.43E-02	2.40E-06
U233	6.74E-06	8.83E-09	9.65E-03	1.02E-01	9.36E-03	4.32E-07
Zr93	1.36E-03	1.78E-06	1.69E+01	5.70E+02	3.59E+01	1.71E-03
(4) Disruptive Event - Enhanced Erosion Case						
Ac227	6.55E-05	8.58E-08	0.00E+00	7.70E-02	1.28E-02	2.18E-05
Mo93	3.47E-08	4.55E-11	0.00E+00	3.00E-04	6.67E-05	3.62E-09
Nb93m	5.00E-03	6.77E-06	0.00E+00	2.57E+02	7.54E+00	7.26E-03
Pu242	6.36E-06	2.09E-08	0.00E+00	1.31E-02	7.23E-01	3.40E-05
Th229	1.52E-07	4.18E-10	0.00E+00	6.26E-02	3.90E-02	7.36E-05
U233	8.41E-06	1.10E-08	0.00E+00	6.56E-02	1.04E-02	5.48E-07
Zr93	5.35E-03	7.14E-06	0.00E+00	2.53E+02	2.53E+01	6.81E-03
(5) Disruptive Event - Localized Cover Failure						
Ac227	1.86E-05	2.43E-08	0.00E+00	1.43E-02	1.06E-02	3.86E-06
Mo93	3.30E-08	4.33E-11	0.00E+00	2.55E-04	7.06E-05	3.60E-09
Nb93m	6.75E-04	8.84E-07	0.00E+00	6.10E+02	1.07E+01	1.82E-03
Pu242	1.36E-05	1.78E-08	0.00E+00	9.71E-03	4.98E-01	2.33E-05

Radiological COPCs	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediments (Bq/kg)	Ottawa River Sediment (Bq/kg)
Th229	1.00E-08	1.31E-11	0.00E+00	8.37E-02	1.44E-02	2.41E-06
U233	6.70E-06	8.78E-09	0.00E+00	1.00E-01	9.31E-03	4.29E-07
Zr93	1.52E-03	1.99E-06	0.00E+00	6.10E+02	3.89E+01	1.92E-03
(6) Disruptive Event - Localized Liner Failure						
Ac227	1.99E-05	2.61E-08	0.00E+00	1.29E-02	1.15E-02	4.16E-06
Mo93	4.67E-08	6.12E-11	0.00E+00	3.05E-04	1.35E-04	5.32E-09
Nb93m	8.66E-04	1.14E-06	0.00E+00	4.33E+02	3.87E+01	5.63E-03
Pu242	1.71E-05	2.24E-08	0.00E+00	1.48E-02	8.94E-01	4.43E-05
Th229	9.73E-09	1.27E-11	0.00E+00	5.85E-02	1.46E-02	2.34E-06
U233	8.02E-06	1.05E-08	0.00E+00	8.90E-02	1.14E-02	5.05E-07
Zr93	4.89E-03	6.40E-06	0.00E+00	4.32E+02	1.36E+02	6.08E-03
(7) Disruptive Event - Damage to Berm						
Ac227	1.96E-05	2.57E-08	0.00E+00	2.10E-02	1.06E-02	3.96E-06
Mo93	5.82E-08	7.62E-11	0.00E+00	4.97E-04	1.20E-04	6.03E-09
Nb93m	6.89E-04	9.03E-07	0.00E+00	6.80E+02	1.03E+01	1.79E-03
Pu242	1.63E-05	2.13E-08	0.00E+00	3.11E-02	7.33E-01	3.38E-05
Th229	1.02E-08	1.34E-11	0.00E+00	1.09E-01	1.42E-02	2.47E-06
U233	6.46E-06	8.46E-09	0.00E+00	1.09E-01	8.79E-03	4.15E-07
Zr93	1.44E-03	1.88E-06	0.00E+00	6.80E+02	3.75E+01	1.82E-03
(8) Dose Optimization - Wastes Grouted into Steel Liners						
Ac227	1.81E-05	2.38E-08	0.00E+00	1.56E-02	1.03E-02	3.77E-06
Mo93	3.85E-08	5.04E-11	0.00E+00	3.58E-04	7.88E-05	3.89E-09
Nb93m	5.87E-04	7.68E-07	0.00E+00	5.71E+02	9.86E+00	1.64E-03
Pu242	1.60E-05	2.09E-08	0.00E+00	1.83E-02	7.26E-01	3.34E-05
Th229	9.98E-09	1.31E-11	0.00E+00	8.34E-02	1.43E-02	2.40E-06
U233	6.74E-06	8.83E-09	0.00E+00	1.02E-01	9.37E-03	4.32E-07
Zr93	1.36E-03	1.78E-06	0.00E+00	5.71E+02	3.60E+01	1.71E-03
(11) Defence-in-Depth - Role of Geosphere						
Ac227	9.33E-05	1.22E-07	0.00E+00	1.56E-02	5.46E-02	5.42E-06
Mo93	4.51E-08	5.91E-11	0.00E+00	3.57E-04	9.84E-05	4.44E-09
Nb93m	2.15E-03	2.82E-06	0.00E+00	5.71E+02	9.84E+01	2.06E-03
Pu242	1.95E-05	2.55E-08	0.00E+00	1.83E-02	9.61E-01	5.53E-05
Th229	5.29E-08	6.93E-11	0.00E+00	8.33E-02	8.52E-02	1.26E-05
U233	7.10E-06	9.30E-09	0.00E+00	1.02E-01	1.04E-02	4.60E-07
Zr93	1.37E-03	1.79E-06	0.00E+00	5.70E+02	3.93E+01	1.74E-03
(12) Defence-in-Depth - Role of Cover						
Ac227	1.90E-05	2.49E-08	0.00E+00	1.39E-02	1.08E-02	3.96E-06
Mo93	4.26E-08	5.57E-11	0.00E+00	4.06E-04	8.72E-05	4.29E-09
Nb93m	9.38E-04	1.23E-06	0.00E+00	7.80E+02	1.39E+01	2.55E-03
Pu242	4.59E-05	6.01E-08	0.00E+00	4.54E-03	2.10E+00	3.20E-05
Th229	1.03E-08	1.35E-11	0.00E+00	9.07E-02	1.47E-02	2.49E-06
U233	6.78E-06	8.88E-09	0.00E+00	1.05E-01	9.43E-03	4.36E-07
Zr93	2.06E-03	2.70E-06	0.00E+00	7.80E+02	5.02E+01	2.65E-03
(13) Defence-in-Depth - Role of Base Liner						
Ac227	2.50E-05	3.27E-08	0.00E+00	7.02E-07	1.47E-02	5.15E-06
Mo93	6.93E-08	9.08E-11	0.00E+00	6.10E-09	2.02E-04	7.34E-09
Nb93m	9.02E-04	1.18E-06	0.00E+00	1.59E-02	4.14E+01	6.53E-03
Pu242	1.41E-05	1.84E-08	0.00E+00	2.32E-07	7.69E-01	3.92E-05

Radiological COPCs	Perch Creek Surface Water (Bq/L)	Ottawa River Surface Water (Bq/L)	Garden Area Soil (Bq/kg)	Grazing Area Soil (Bq/kg)	Perch Creek Sediments (Bq/kg)	Ottawa River Sediment (Bq/kg)
Th229	1.19E-08	1.56E-11	0.00E+00	6.99E-07	1.96E-02	2.87E-06
U233	8.09E-06	1.06E-08	0.00E+00	1.90E-06	1.18E-02	5.28E-07
Zr93	5.44E-03	7.12E-06	0.00E+00	1.61E-02	1.52E+02	7.06E-03
(14) Defence-in-Depth - Series of Landslides						
Ac227	4.56E-05	5.98E-08	0.00E+00	3.95E-02	1.52E-02	5.44E-05
Mo93	6.13E-08	8.15E-11	0.00E+00	3.27E-04	8.15E-05	6.56E-09
Nb93m	2.62E-02	4.39E-05	0.00E+00	4.71E+02	1.29E+01	4.62E-02
Pu242	1.60E-05	2.09E-08	0.00E+00	3.11E-02	7.25E-01	1.86E-04
Th229	5.81E-07	1.37E-09	0.00E+00	4.72E-02	3.60E-02	2.31E-04
U233	2.19E-05	2.90E-08	0.00E+00	1.83E-01	9.59E-03	1.43E-06
Zr93	2.87E-02	4.38E-05	0.00E+00	4.86E+02	2.77E+01	4.29E-02
(15) What If - Human Intrusion, Mass Excavation and Farming						
Ac227	6.36E-05	8.33E-08	8.22E-03	2.47E-02	2.82E-02	1.09E-05
Am241	4.23E-02	5.53E-05	2.68E+01	4.90E+01	1.33E+03	3.49E-02
C14	4.39E+00	5.67E-03	1.70E+01	7.34E+01	6.43E+03	1.49E-01
Cl36	2.17E-02	2.84E-05	1.48E-03	4.11E-02	1.23E+01	1.38E-04
Mo93	4.57E-08	5.99E-11	7.55E-05	3.71E-04	1.25E-04	5.47E-09
Nb93m	9.49E-03	1.24E-05	2.11E+02	8.25E+02	1.63E+01	3.79E-03
Po210	2.06E-01	2.67E-04	1.18E+01	1.92E+01	2.69E-01	8.52E-04
Pu239	1.05E-01	1.37E-04	1.68E+01	3.64E+01	4.10E+03	6.32E-02
Pu242	8.31E-05	1.09E-07	1.33E-02	2.88E-02	3.25E+00	5.01E-05
Ra226	1.42E-04	1.86E-07	1.79E+01	2.34E+01	2.80E+00	9.74E-04
Th228	3.12E-05	4.09E-08	1.68E+01	1.03E+02	2.00E+00	1.86E-03
Th229	1.56E-08	2.04E-11	3.74E-03	1.09E-01	2.10E-02	3.80E-06
U233	9.79E-06	1.28E-08	9.17E-02	1.36E-01	1.33E-02	6.39E-07
Zr93	1.42E-02	1.86E-05	2.12E+02	8.61E+02	5.87E+01	3.77E-03
(17) What If - Permanent Bathtub						
Ac227	5.52E-05	7.23E-08	0.00E+00	4.51E-02	1.24E-02	6.99E-06
Mo93	3.92E-08	5.14E-11	0.00E+00	3.60E-04	8.03E-05	3.98E-09
Nb93m	2.94E-03	3.85E-06	0.00E+00	8.83E+02	2.14E+01	4.35E-03
Pu242	1.60E-05	2.09E-08	0.00E+00	2.04E-02	7.25E-01	3.34E-05
Th229	1.45E-08	1.90E-11	0.00E+00	4.29E-01	1.11E-02	3.50E-06
U233	5.92E-06	7.75E-09	0.00E+00	1.05E-01	6.51E-03	3.86E-07
Zr93	3.17E-03	4.15E-06	0.00E+00	8.83E+02	6.62E+01	4.10E-03

Note: Exposure Point Concentration – maximum predicted concentration over the entire PostSA assessment timeframe (10,000 years).
COPC – Constituent of Potential Concern.

Table 3-3 Exposure Point Concentrations (Bq/kg FW) of Radiological COPCs in Consumed Foods Calculated Using Transfer Factors

Radiological COPCs	Terrestrial Vegetation [1]		Earthworm [1]		Seeds [1]		Fish [1]		Benthic Invertebrates [2]		Aquatic Vegetation [1]	
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Ottawa River	Perch Creek	Ottawa River	Perch Creek	Ottawa River	Perch Creek
(1) Normal Evolution Scenario and (9) Dose Optimization - Confidence in Land Use Restrictions												
Ac227	0.00E+00	1.09E-05	0.00E+00	0.00E+00	0.00E+00	4.95E-06	6.14E-07	4.69E-04	2.45E-05	1.87E-02	2.45E-04	1.87E-01
Mo93	0.00E+00	2.57E-05	0.00E+00	5.80E-05	0.00E+00	1.17E-04	1.36E-09	1.04E-06	1.81E-10	1.38E-07	1.21E-08	9.23E-06
Nb93m	0.00E+00	3.31E+00	0.00E+00	8.73E+01	0.00E+00	1.50E+01	2.30E-04	1.76E-01	7.68E-05	5.86E-02	9.21E-04	7.03E-01
Pu242	0.00E+00	5.12E-07	0.00E+00	7.31E-03	0.00E+00	2.32E-06	4.39E-04	3.35E-01	1.50E-05	1.15E-02	8.36E-05	6.38E-02
Th229	0.00E+00	5.50E-05	0.00E+00	7.64E-04	0.00E+00	2.49E-04	2.48E-09	1.89E-06	1.17E-08	8.97E-06	1.57E-08	1.20E-05
U233	0.00E+00	2.03E-04	0.00E+00	5.37E-04	0.00E+00	9.22E-04	2.12E-08	1.62E-05	8.74E-07	6.67E-04	2.65E-06	2.02E-03
Zr93	0.00E+00	3.65E-01	0.00E+00	5.44E+00	0.00E+00	1.65E+00	1.69E-04	1.29E-01	5.34E-03	4.08E+00	5.70E-03	4.35E+00
(1a) NES Sensitivity Analysis - Inventory Sensitivity												
Ac227	0.00E+00	1.06E-04	0.00E+00	0.00E+00	0.00E+00	4.82E-05	2.54E-06	1.94E-03	1.01E-04	7.75E-02	1.01E-03	7.75E-01
Am241	0.00E+00	7.19E-03	0.00E+00	1.56E+01	0.00E+00	3.26E-02	8.00E-03	6.11E+00	4.00E-02	3.05E+01	1.03E-01	7.89E+01
C14	3.32E+04	3.32E+03	3.68E+04	3.68E+03	1.51E+05	1.50E+04	6.03E+00	4.66E+03	5.50E+00	4.25E+03	6.24E+00	4.82E+03
Cl36	0.00E+00	4.67E+00	0.00E+00	4.67E-02	0.00E+00	2.12E+01	7.72E-03	5.90E+00	1.14E-02	8.69E+00	4.07E-03	3.10E+00
I129	0.00E+00	2.41E+00	0.00E+00	3.76E+01	0.00E+00	1.09E+01	2.94E-01	2.24E+02	4.34E-03	3.31E+00	3.21E-02	2.45E+01
Mo93	0.00E+00	2.57E-04	0.00E+00	5.80E-04	0.00E+00	1.17E-03	1.36E-08	1.04E-05	1.81E-09	1.38E-06	1.21E-07	9.23E-05
Nb93m	0.00E+00	3.31E+01	0.00E+00	8.73E+02	0.00E+00	1.50E+02	2.30E-03	1.76E+00	7.68E-04	5.86E-01	9.21E-03	7.03E+00
Po210	0.00E+00	1.57E+00	0.00E+00	1.22E+00	0.00E+00	3.00E-02	1.07E-03	8.29E-01	5.97E-01	4.61E+02	5.97E-02	4.61E+01
Pu239	0.00E+00	6.78E-03	0.00E+00	9.68E+01	0.00E+00	3.07E-02	6.00E+00	4.58E+03	2.06E-01	1.57E+02	1.14E+00	8.73E+02
Pu242	0.00E+00	5.12E-06	0.00E+00	7.31E-02	0.00E+00	2.32E-05	4.39E-03	3.35E+00	1.50E-04	1.15E-01	8.36E-04	6.38E-01
Ra226	0.00E+00	3.25E+00	0.00E+00	6.41E+00	0.00E+00	1.48E+01	3.14E-05	2.40E-02	1.65E-05	1.26E-02	3.29E-04	2.51E-01
Th228	0.00E+00	9.70E-02	0.00E+00	1.35E+00	0.00E+00	4.40E-01	1.35E-07	1.02E-04	6.39E-07	4.82E-04	8.52E-07	6.43E-04
Th229	0.00E+00	1.69E-04	0.00E+00	2.35E-03	0.00E+00	7.68E-04	5.15E-09	3.94E-06	2.44E-08	1.86E-05	3.26E-08	2.49E-05
U233	0.00E+00	4.13E-04	0.00E+00	1.09E-03	0.00E+00	1.87E-03	4.48E-08	3.42E-05	1.85E-06	1.41E-03	5.60E-06	4.28E-03
Zr93	0.00E+00	3.65E+00	0.00E+00	5.44E+01	0.00E+00	1.65E+01	1.69E-03	1.29E+00	5.34E-02	4.08E+01	5.70E-02	4.35E+01
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity												
Ac227	0.00E+00	1.09E-05	0.00E+00	0.00E+00	0.00E+00	4.95E-06	6.14E-07	4.69E-04	2.45E-05	1.87E-02	2.45E-04	1.87E-01
Mo93	0.00E+00	2.57E-05	0.00E+00	5.80E-05	0.00E+00	1.17E-04	1.36E-09	1.04E-06	1.81E-10	1.38E-07	1.21E-08	9.23E-06
Nb93m	0.00E+00	3.31E+00	0.00E+00	8.73E+01	0.00E+00	1.50E+01	2.30E-04	1.76E-01	7.68E-05	5.86E-02	9.21E-04	7.03E-01
Pu242	0.00E+00	5.12E-07	0.00E+00	7.31E-03	0.00E+00	2.32E-06	4.39E-04	3.35E-01	1.50E-05	1.15E-02	8.36E-05	6.38E-02
Th229	0.00E+00	5.50E-05	0.00E+00	7.64E-04	0.00E+00	2.49E-04	2.48E-09	1.89E-06	1.17E-08	8.97E-06	1.57E-08	1.20E-05
U233	0.00E+00	2.03E-04	0.00E+00	5.37E-04	0.00E+00	9.22E-04	2.12E-08	1.62E-05	8.74E-07	6.67E-04	2.65E-06	2.02E-03
Zr93	0.00E+00	3.65E-01	0.00E+00	5.44E+00	0.00E+00	1.65E+00	1.69E-04	1.29E-01	5.34E-03	4.08E+00	5.70E-03	4.35E+00
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity												
Ac227	0.00E+00	6.09E-05	0.00E+00	0.00E+00	0.00E+00	2.76E-05	2.40E-06	1.84E-03	9.61E-05	7.34E-02	9.61E-04	7.34E-01
Am241	0.00E+00	1.47E-03	0.00E+00	3.20E+00	0.00E+00	6.68E-03	7.53E-03	5.75E+00	3.76E-02	2.87E+01	9.72E-02	7.43E+01
C14	3.32E+03	8.23E+02	3.68E+03	9.14E+02	1.51E+04	3.73E+03	3.18E+00	2.46E+03	2.90E+00	2.24E+03	3.29E+00	2.54E+03
Cl36	0.00E+00	1.91E-01	0.00E+00	1.91E-03	0.00E+00	8.67E-01	1.07E-03	8.20E-01	1.58E-03	1.21E+00	5.65E-04	4.32E-01
Mo93	0.00E+00	4.17E-05	0.00E+00	9.41E-05	0.00E+00	1.89E-04	3.80E-09	2.91E-06	5.07E-10	3.87E-07	3.38E-08	2.58E-05
Nb93m	0.00E+00	2.32E+01	0.00E+00	6.11E+02	0.00E+00	1.05E+02	2.45E-03	1.87E+00	8.15E-04	6.22E-01	9.78E-03	7.46E+00
Po210	0.00E+00	1.27E+00	0.00E+00	9.90E-01	0.00E+00	2.43E-02	8.84E-04	6.82E-01	4.91E-01	3.79E+02	4.91E-02	3.79E+01
Pu239	0.00E+00	1.07E-03	0.00E+00	1.53E+01	0.00E+00	4.86E-03	1.55E+00	1.18E+03	5.30E-02	4.05E+01	2.95E-01	2.25E+02
Pu242	0.00E+00	8.01E-07	0.00E+00	1.14E-02	0.00E+00	3.63E-06	1.13E-03	8.63E-01	3.87E-05	2.96E-02	2.15E-04	1.64E-01
Ra226	0.00E+00	2.68E+00	0.00E+00	5.28E+00	0.00E+00	1.22E+01	2.47E-05	1.89E-02	1.29E-05	9.88E-03	2.59E-04	1.98E-01
Th228	0.00E+00	9.68E-02	0.00E+00	1.34E+00	0.00E+00	4.39E-01	1.35E-07	1.02E-04	6.39E-07	4.82E-04	8.53E-07	6.43E-04
Th229	0.00E+00	1.56E-04	0.00E+00	2.17E-03	0.00E+00	7.09E-04	6.96E-09	5.31E-06	3.30E-08	2.52E-05	4.39E-08	3.36E-05
Th232	0.00E+00	9.72E-02	0.00E+00	1.35E+00	0.00E+00	4.41E-01	1.32E-07	1.01E-04	6.26E-07	4.78E-04	8.34E-07	6.37E-04

Radiological COPCs	Terrestrial Vegetation [1]		Earthworm [1]		Seeds [1]		Fish [1]		Benthic Invertebrates [2]		Aquatic Vegetation [1]	
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Ottawa River	Perch Creek	Ottawa River	Perch Creek	Ottawa River	Perch Creek
U233	0.00E+00	4.13E-04	0.00E+00	1.09E-03	0.00E+00	1.87E-03	5.17E-08	3.95E-05	2.13E-06	1.63E-03	6.46E-06	4.93E-03
U234	0.00E+00	1.02E-01	0.00E+00	2.68E-01	0.00E+00	4.61E-01	1.34E-05	1.02E-02	5.51E-04	4.21E-01	1.67E-03	1.27E+00
Zr93	0.00E+00	2.56E+00	0.00E+00	3.82E+01	0.00E+00	1.16E+01	3.93E-03	3.00E+00	1.24E-01	9.49E+01	1.33E-01	1.01E+02
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek												
Ac227	0.00E+00	1.09E-05	0.00E+00	0.00E+00	0.00E+00	4.95E-06	6.42E-07	4.91E-04	2.57E-05	1.96E-02	2.57E-04	1.96E-01
Mo93	0.00E+00	2.57E-05	0.00E+00	5.80E-05	0.00E+00	1.17E-04	1.49E-09	1.14E-06	1.99E-10	1.52E-07	1.33E-08	1.01E-05
Nb93m	0.00E+00	3.31E+00	0.00E+00	8.73E+01	0.00E+00	1.50E+01	2.31E-04	1.77E-01	7.71E-05	5.88E-02	9.25E-04	7.06E-01
Pu242	0.00E+00	5.12E-07	0.00E+00	7.31E-03	0.00E+00	2.32E-06	4.76E-04	3.64E-01	1.63E-05	1.25E-02	9.07E-05	6.93E-02
Th229	0.00E+00	5.50E-05	0.00E+00	7.64E-04	0.00E+00	2.49E-04	2.56E-09	1.96E-06	1.21E-08	9.27E-06	1.62E-08	1.24E-05
U233	0.00E+00	2.03E-04	0.00E+00	5.37E-04	0.00E+00	9.22E-04	2.19E-08	1.67E-05	9.02E-07	6.89E-04	2.73E-06	2.09E-03
Zr93	0.00E+00	3.65E-01	0.00E+00	5.44E+00	0.00E+00	1.65E+00	1.65E-04	1.26E-01	5.22E-03	3.99E+00	5.57E-03	4.25E+00
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner												
Ac227	0.00E+00	2.28E-06	0.00E+00	0.00E+00	0.00E+00	1.03E-06	6.25E-07	4.78E-04	2.50E-05	1.91E-02	2.50E-04	1.91E-01
Mo93	0.00E+00	2.72E-05	0.00E+00	6.12E-05	0.00E+00	1.23E-04	1.26E-09	9.61E-07	1.68E-10	1.28E-07	1.12E-08	8.54E-06
Nb93m	0.00E+00	1.49E+00	0.00E+00	3.94E+01	0.00E+00	6.77E+00	1.03E-04	7.86E-02	3.44E-05	2.62E-02	4.12E-04	3.15E-01
Pu242	0.00E+00	1.55E-07	0.00E+00	2.22E-03	0.00E+00	7.04E-07	7.79E-04	5.95E-01	2.67E-05	2.04E-02	1.48E-04	1.13E-01
Th229	0.00E+00	7.57E-06	0.00E+00	1.05E-04	0.00E+00	3.43E-05	2.39E-09	1.82E-06	1.13E-08	8.64E-06	1.51E-08	1.15E-05
U233	0.00E+00	1.74E-04	0.00E+00	4.58E-04	0.00E+00	7.87E-04	2.08E-08	1.58E-05	8.56E-07	6.54E-04	2.59E-06	1.98E-03
Zr93	0.00E+00	1.64E-01	0.00E+00	2.44E+00	0.00E+00	7.42E-01	1.27E-04	9.70E-02	4.01E-03	3.06E+00	4.28E-03	3.27E+00
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER												
Ac227	0.00E+00	1.03E-05	0.00E+00	0.00E+00	0.00E+00	4.67E-06	5.62E-07	4.29E-04	2.25E-05	1.72E-02	2.25E-04	1.72E-01
Mo93	0.00E+00	2.46E-05	0.00E+00	5.54E-05	0.00E+00	1.12E-04	1.19E-09	9.08E-07	1.59E-10	1.21E-07	1.06E-08	8.07E-06
Nb93m	0.00E+00	2.65E+00	0.00E+00	6.98E+01	0.00E+00	1.20E+01	1.61E-04	1.23E-01	5.36E-05	4.09E-02	6.43E-04	4.91E-01
Pu242	0.00E+00	4.97E-07	0.00E+00	7.10E-03	0.00E+00	2.25E-06	3.63E-04	2.77E-01	1.24E-05	9.50E-03	6.91E-05	5.28E-02
Th229	0.00E+00	3.50E-05	0.00E+00	4.86E-04	0.00E+00	1.59E-04	2.24E-09	1.71E-06	1.06E-08	8.10E-06	1.42E-08	1.08E-05
U233	0.00E+00	1.93E-04	0.00E+00	5.10E-04	0.00E+00	8.77E-04	1.88E-08	1.44E-05	7.76E-07	5.92E-04	2.35E-06	1.80E-03
Zr93	0.00E+00	2.92E-01	0.00E+00	4.35E+00	0.00E+00	1.32E+00	1.28E-04	9.79E-02	4.05E-03	3.09E+00	4.32E-03	3.30E+00
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)												
Ac227	4.07E-07	1.09E-05	0.00E+00	0.00E+00	1.85E-07	4.95E-06	6.14E-07	4.69E-04	2.45E-05	1.87E-02	2.45E-04	1.87E-01
Mo93	3.48E-07	2.57E-05	7.85E-07	5.80E-05	1.58E-06	1.17E-04	1.36E-09	1.04E-06	1.81E-10	1.38E-07	1.21E-08	9.23E-06
Nb93m	9.68E-02	3.31E+00	2.55E+00	8.73E+01	4.39E-01	1.50E+01	2.30E-04	1.76E-01	7.68E-05	5.86E-02	9.21E-04	7.03E-01
Pu242	6.29E-08	5.12E-07	8.99E-04	7.31E-03	2.85E-07	2.32E-06	4.39E-04	3.35E-01	1.50E-05	1.15E-02	8.36E-05	6.38E-02
Th229	3.97E-07	5.50E-05	5.52E-06	7.64E-04	1.80E-06	2.49E-04	2.48E-09	1.89E-06	1.17E-08	8.97E-06	1.57E-08	1.20E-05
U233	1.93E-05	2.03E-04	5.09E-05	5.37E-04	8.75E-05	9.22E-04	2.12E-08	1.62E-05	8.74E-07	6.67E-04	2.65E-06	2.02E-03
Zr93	1.08E-02	3.65E-01	1.61E-01	5.44E+00	4.90E-02	1.65E+00	1.69E-04	1.29E-01	5.34E-03	4.08E+00	5.70E-03	4.35E+00
(4) Disruptive Event - Enhanced Erosion Case												
Ac227	0.00E+00	5.39E-05	0.00E+00	0.00E+00	0.00E+00	2.44E-05	2.14E-06	1.64E-03	8.58E-05	6.55E-02	8.58E-05	6.55E-02
Mo93	0.00E+00	2.16E-05	0.00E+00	4.86E-05	0.00E+00	9.79E-05	1.23E-09	9.37E-07	1.64E-10	1.25E-07	1.64E-10	1.25E-07
Nb93m	0.00E+00	1.49E+00	0.00E+00	3.94E+01	0.00E+00	6.77E+00	2.03E-03	1.50E+00	6.77E-04	5.00E-01	6.77E-04	5.00E-01
Pu242	0.00E+00	3.67E-07	0.00E+00	5.24E-03	0.00E+00	1.66E-06	4.38E-04	1.34E-01	1.50E-05	4.58E-03	1.50E-05	4.58E-03
Th229	0.00E+00	4.13E-05	0.00E+00	5.74E-04	0.00E+00	1.87E-04	7.95E-08	2.89E-05	3.76E-07	1.37E-04	3.76E-07	1.37E-04
U233	0.00E+00	1.31E-04	0.00E+00	3.46E-04	0.00E+00	5.95E-04	2.65E-08	2.02E-05	1.09E-06	8.32E-04	1.09E-06	8.32E-04
Zr93	0.00E+00	1.62E-01	0.00E+00	2.42E+00	0.00E+00	7.35E-01	6.79E-04	5.08E-01	2.14E-02	1.60E+01	2.14E-02	1.60E+01
(5) Disruptive Event - Localized Cover Failure												
Ac227	0.00E+00	9.98E-06	0.00E+00	0.00E+00	0.00E+00	4.53E-06	6.07E-07	4.64E-04	2.43E-05	1.86E-02	2.43E-04	1.86E-01
Mo93	0.00E+00	1.84E-05	0.00E+00	4.14E-05	0.00E+00	8.34E-05	1.17E-09	8.92E-07	1.56E-10	1.19E-07	1.04E-08	7.93E-06
Nb93m	0.00E+00	3.54E+00	0.00E+00	9.34E+01	0.00E+00	1.61E+01	2.65E-04	2.02E-01	8.84E-05	6.75E-02	1.06E-03	8.10E-01
Pu242	0.00E+00	2.72E-07	0.00E+00	3.88E-03	0.00E+00	1.23E-06	3.73E-04	2.85E-01	1.28E-05	9.77E-03	7.11E-05	5.43E-02

Radiological COPCs	Terrestrial Vegetation [1]		Earthworm [1]		Seeds [1]		Fish [1]		Benthic Invertebrates [2]		Aquatic Vegetation [1]	
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Ottawa River	Perch Creek	Ottawa River	Perch Creek	Ottawa River	Perch Creek
Th229	0.00E+00	5.53E-05	0.00E+00	7.68E-04	0.00E+00	2.51E-04	2.50E-09	1.91E-06	1.18E-08	9.03E-06	1.58E-08	1.20E-05
U233	0.00E+00	2.00E-04	0.00E+00	5.29E-04	0.00E+00	9.09E-04	2.11E-08	1.61E-05	8.69E-07	6.63E-04	2.63E-06	2.01E-03
Zr93	0.00E+00	3.90E-01	0.00E+00	5.83E+00	0.00E+00	1.77E+00	1.89E-04	1.44E-01	5.97E-03	4.56E+00	6.37E-03	4.86E+00
(6) Disruptive Event - Localized Liner Failure												
Ac227	0.00E+00	9.05E-06	0.00E+00	0.00E+00	0.00E+00	4.10E-06	6.53E-07	4.98E-04	2.61E-05	1.99E-02	2.61E-04	1.99E-01
Mo93	0.00E+00	2.19E-05	0.00E+00	4.94E-05	0.00E+00	9.95E-05	1.65E-09	1.26E-06	2.20E-10	1.68E-07	1.47E-08	1.12E-05
Nb93m	0.00E+00	2.51E+00	0.00E+00	6.62E+01	0.00E+00	1.14E+01	3.41E-04	2.60E-01	1.14E-04	8.66E-02	1.36E-03	1.04E+00
Pu242	0.00E+00	4.15E-07	0.00E+00	5.93E-03	0.00E+00	1.88E-06	4.71E-04	3.59E-01	1.61E-05	1.23E-02	8.96E-05	6.84E-02
Th229	0.00E+00	3.86E-05	0.00E+00	5.37E-04	0.00E+00	1.75E-04	2.42E-09	1.85E-06	1.15E-08	8.76E-06	1.53E-08	1.17E-05
U233	0.00E+00	1.78E-04	0.00E+00	4.70E-04	0.00E+00	8.07E-04	2.52E-08	1.93E-05	1.04E-06	7.94E-04	3.15E-06	2.41E-03
Zr93	0.00E+00	2.77E-01	0.00E+00	4.13E+00	0.00E+00	1.25E+00	6.08E-04	4.64E-01	1.92E-02	1.47E+01	2.05E-02	1.56E+01
(7) Disruptive Event - Damage to Berm												
Ac227	0.00E+00	1.47E-05	0.00E+00	0.00E+00	0.00E+00	6.66E-06	6.42E-07	4.91E-04	2.57E-05	1.96E-02	2.57E-04	1.96E-01
Mo93	0.00E+00	3.58E-05	0.00E+00	8.06E-05	0.00E+00	1.62E-04	2.06E-09	1.57E-06	2.74E-10	2.09E-07	1.83E-08	1.40E-05
Nb93m	0.00E+00	3.94E+00	0.00E+00	1.04E+02	0.00E+00	1.79E+01	2.71E-04	2.07E-01	9.03E-05	6.89E-02	1.08E-03	8.27E-01
Pu242	0.00E+00	8.71E-07	0.00E+00	1.24E-02	0.00E+00	3.95E-06	4.48E-04	3.42E-01	1.53E-05	1.17E-02	8.53E-05	6.51E-02
Th229	0.00E+00	7.16E-05	0.00E+00	9.95E-04	0.00E+00	3.25E-04	2.55E-09	1.95E-06	1.21E-08	9.22E-06	1.61E-08	1.23E-05
U233	0.00E+00	2.19E-04	0.00E+00	5.77E-04	0.00E+00	9.91E-04	2.03E-08	1.55E-05	8.37E-07	6.39E-04	2.54E-06	1.94E-03
Zr93	0.00E+00	4.35E-01	0.00E+00	6.49E+00	0.00E+00	1.97E+00	1.79E-04	1.37E-01	5.65E-03	4.31E+00	6.02E-03	4.60E+00
(8) Dose Optimization - Wastes Grouted into Steel Liners												
Ac227	0.00E+00	1.09E-05	0.00E+00	0.00E+00	0.00E+00	4.95E-06	5.94E-07	4.54E-04	2.38E-05	1.81E-02	2.38E-04	1.81E-01
Mo93	0.00E+00	2.58E-05	0.00E+00	5.80E-05	0.00E+00	1.17E-04	1.36E-09	1.04E-06	1.81E-10	1.38E-07	1.21E-08	9.23E-06
Nb93m	0.00E+00	3.31E+00	0.00E+00	8.74E+01	0.00E+00	1.50E+01	2.31E-04	1.76E-01	7.68E-05	5.87E-02	9.22E-04	7.04E-01
Pu242	0.00E+00	5.12E-07	0.00E+00	7.32E-03	0.00E+00	2.32E-06	4.39E-04	3.35E-01	1.51E-05	1.15E-02	8.37E-05	6.39E-02
Th229	0.00E+00	5.50E-05	0.00E+00	7.65E-04	0.00E+00	2.50E-04	2.48E-09	1.90E-06	1.18E-08	8.98E-06	1.57E-08	1.20E-05
U233	0.00E+00	2.04E-04	0.00E+00	5.37E-04	0.00E+00	9.23E-04	2.12E-08	1.62E-05	8.75E-07	6.68E-04	2.65E-06	2.02E-03
Zr93	0.00E+00	3.65E-01	0.00E+00	5.45E+00	0.00E+00	1.66E+00	1.69E-04	1.29E-01	5.35E-03	4.08E+00	5.71E-03	4.36E+00
(11) Defence-in-Depth - Role of Geosphere												
Ac227	0.00E+00	1.09E-05	0.00E+00	0.00E+00	0.00E+00	4.95E-06	3.06E-06	2.33E-03	1.22E-04	9.33E-02	1.22E-03	9.33E-01
Mo93	0.00E+00	2.57E-05	0.00E+00	5.80E-05	0.00E+00	1.17E-04	1.60E-09	1.22E-06	2.13E-10	1.63E-07	1.42E-08	1.08E-05
Nb93m	0.00E+00	3.31E+00	0.00E+00	8.73E+01	0.00E+00	1.50E+01	8.46E-04	6.46E-01	2.82E-04	2.15E-01	3.38E-03	2.58E+00
Pu242	0.00E+00	5.12E-07	0.00E+00	7.31E-03	0.00E+00	2.32E-06	5.36E-04	4.09E-01	1.84E-05	1.40E-02	1.02E-04	7.79E-02
Th229	0.00E+00	5.50E-05	0.00E+00	7.64E-04	0.00E+00	2.49E-04	1.32E-08	1.00E-05	6.23E-08	4.76E-05	8.31E-08	6.35E-05
U233	0.00E+00	2.03E-04	0.00E+00	5.37E-04	0.00E+00	9.22E-04	2.23E-08	1.70E-05	9.21E-07	7.03E-04	2.79E-06	2.13E-03
Zr93	0.00E+00	3.65E-01	0.00E+00	5.44E+00	0.00E+00	1.65E+00	1.70E-04	1.30E-01	5.37E-03	4.10E+00	5.73E-03	4.38E+00
(12) Defence-in-Depth - Role of Cover												
Ac227	0.00E+00	9.74E-06	0.00E+00	0.00E+00	0.00E+00	4.42E-06	6.22E-07	4.75E-04	2.49E-05	1.90E-02	2.49E-04	1.90E-01
Mo93	0.00E+00	2.93E-05	0.00E+00	6.59E-05	0.00E+00	1.33E-04	1.51E-09	1.15E-06	2.01E-10	1.53E-07	1.34E-08	1.02E-05
Nb93m	0.00E+00	4.53E+00	0.00E+00	1.19E+02	0.00E+00	2.05E+01	3.69E-04	2.81E-01	1.23E-04	9.38E-02	1.47E-03	1.13E+00
Pu242	0.00E+00	1.27E-07	0.00E+00	1.82E-03	0.00E+00	5.77E-07	1.26E-03	9.63E-01	4.33E-05	3.30E-02	2.40E-04	1.83E-01
Th229	0.00E+00	5.98E-05	0.00E+00	8.31E-04	0.00E+00	2.71E-04	2.57E-09	1.96E-06	1.22E-08	9.30E-06	1.62E-08	1.24E-05
U233	0.00E+00	2.11E-04	0.00E+00	5.56E-04	0.00E+00	9.56E-04	2.13E-08	1.63E-05	8.79E-07	6.71E-04	2.66E-06	2.03E-03
Zr93	0.00E+00	4.99E-01	0.00E+00	7.45E+00	0.00E+00	2.26E+00	2.56E-04	1.96E-01	8.09E-03	6.17E+00	8.62E-03	6.59E+00
(13) Defence-in-Depth - Role of Base Liner												
Ac227	0.00E+00	4.92E-10	0.00E+00	0.00E+00	0.00E+00	2.23E-10	8.17E-07	6.24E-04	3.27E-05	2.50E-02	3.27E-04	2.50E-01
Mo93	0.00E+00	4.39E-10	0.00E+00	9.89E-10	0.00E+00	1.99E-09	2.45E-09	1.87E-06	3.27E-10	2.49E-07	2.18E-08	1.66E-05
Nb93m	0.00E+00	9.21E-05	0.00E+00	2.43E-03	0.00E+00	4.18E-04	3.55E-04	2.70E-01	1.18E-04	9.02E-02	1.42E-03	1.08E+00
Pu242	0.00E+00	6.48E-12	0.00E+00	9.26E-08	0.00E+00	2.94E-11	3.86E-04	2.95E-01	1.33E-05	1.01E-02	7.36E-05	5.62E-02

Radiological COPCs	Terrestrial Vegetation [1]		Earthworm [1]		Seeds [1]		Fish [1]		Benthic Invertebrates [2]		Aquatic Vegetation [1]	
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Ottawa River	Perch Creek	Ottawa River	Perch Creek	Ottawa River	Perch Creek
Th229	0.00E+00	4.62E-10	0.00E+00	6.41E-09	0.00E+00	2.09E-09	2.96E-09	2.26E-06	1.40E-08	1.07E-05	1.87E-08	1.43E-05
U233	0.00E+00	3.79E-09	0.00E+00	1.00E-08	0.00E+00	1.72E-08	2.54E-08	1.94E-05	1.05E-06	8.01E-04	3.18E-06	2.43E-03
Zr93	0.00E+00	1.03E-05	0.00E+00	1.54E-04	0.00E+00	4.67E-05	6.77E-04	5.17E-01	2.14E-02	1.63E+01	2.28E-02	1.74E+01
(14) Defence-in-Depth - Series of Landslides												
Ac227	0.00E+00	2.77E-05	0.00E+00	0.00E+00	0.00E+00	1.26E-05	1.49E-06	1.14E-03	5.98E-05	4.56E-02	5.98E-04	4.56E-01
Mo93	0.00E+00	2.36E-05	0.00E+00	5.31E-05	0.00E+00	1.07E-04	2.20E-09	1.66E-06	2.93E-10	2.21E-07	1.95E-08	1.47E-05
Nb93m	0.00E+00	2.73E+00	0.00E+00	7.20E+01	0.00E+00	1.24E+01	1.32E-02	7.85E+00	4.39E-03	2.62E+00	5.27E-02	3.14E+01
Pu242	0.00E+00	8.70E-07	0.00E+00	1.24E-02	0.00E+00	3.94E-06	4.39E-04	3.35E-01	1.50E-05	1.15E-02	8.36E-05	6.38E-02
Th229	0.00E+00	3.12E-05	0.00E+00	4.33E-04	0.00E+00	1.41E-04	2.60E-07	1.10E-04	1.23E-06	5.23E-04	1.64E-06	6.97E-04
U233	0.00E+00	3.65E-04	0.00E+00	9.65E-04	0.00E+00	1.66E-03	6.96E-08	5.26E-05	2.87E-06	2.17E-03	8.70E-06	6.58E-03
Zr93	0.00E+00	3.11E-01	0.00E+00	4.64E+00	0.00E+00	1.41E+00	4.16E-03	2.72E+00	1.31E-01	8.60E+01	1.40E-01	9.17E+01
(15) What If - Human Intrusion, Mass Excavation and Farming												
Ac227	5.75E-06	1.73E-05	0.00E+00	0.00E+00	2.61E-06	7.84E-06	2.08E-06	1.59E-03	8.33E-05	6.36E-02	8.33E-04	6.36E-01
Am241	3.38E-03	6.18E-03	7.34E+00	1.34E+01	1.53E-02	2.80E-02	1.33E-02	1.01E+01	6.64E-02	5.07E+01	1.72E-01	1.31E+02
C14	3.32E+03	1.43E+04	3.68E+03	1.59E+04	1.51E+04	6.49E+04	3.23E+01	2.50E+04	2.95E+01	2.28E+04	3.35E+01	2.59E+04
Cl36	2.63E-02	7.32E-01	2.63E-04	7.32E-03	1.19E-01	3.32E+00	2.70E-03	2.07E+00	3.97E-03	3.04E+00	1.42E-03	1.09E+00
Mo93	5.44E-06	2.67E-05	1.23E-05	6.02E-05	2.47E-05	1.21E-04	1.62E-09	1.23E-06	2.15E-10	1.65E-07	1.44E-08	1.10E-05
Nb93m	1.23E+00	4.79E+00	3.23E+01	1.26E+02	5.56E+00	2.17E+01	3.73E-03	2.85E+00	1.24E-03	9.49E-01	1.49E-02	1.14E+01
Po210	1.50E-01	2.46E-01	1.17E-01	1.92E-01	2.88E-03	4.71E-03	9.61E-03	7.42E+00	5.34E+00	4.12E+03	5.34E-01	4.12E+02
Pu239	4.70E-04	1.02E-03	6.72E+00	1.46E+01	2.13E-03	4.62E-03	2.88E+00	2.20E+03	9.89E-02	7.55E+01	5.49E-01	4.19E+02
Pu242	3.72E-07	8.06E-07	5.32E-03	1.15E-02	1.69E-06	3.65E-06	2.29E-03	1.75E+00	7.84E-05	5.98E-02	4.35E-04	3.32E-01
Ra226	3.94E-01	5.16E-01	7.75E-01	1.01E+00	1.79E+00	2.34E+00	3.90E-05	2.98E-02	2.04E-05	1.56E-02	4.09E-04	3.12E-01
Th228	1.11E-02	6.83E-02	1.54E-01	9.49E-01	5.02E-02	3.10E-01	7.77E-06	5.93E-03	3.68E-05	2.81E-02	4.91E-05	3.74E-02
Th229	2.47E-06	7.17E-05	3.43E-05	9.97E-04	1.12E-05	3.25E-04	3.88E-09	2.96E-06	1.84E-08	1.40E-05	2.45E-08	1.87E-05
U233	1.83E-04	2.73E-04	4.84E-04	7.20E-04	8.31E-04	1.24E-03	3.08E-08	2.35E-05	1.27E-06	9.69E-04	3.85E-06	2.94E-03
Zr93	1.36E-01	5.51E-01	2.02E+00	8.22E+00	6.15E-01	2.50E+00	1.76E-03	1.35E+00	5.57E-02	4.26E+01	5.94E-02	4.54E+01
(17) What If - Permanent Bathtub												
Ac227	0.00E+00	3.15E-05	0.00E+00	0.00E+00	0.00E+00	1.43E-05	1.81E-06	1.38E-03	7.23E-05	5.52E-02	7.23E-04	5.52E-01
Mo93	0.00E+00	2.59E-05	0.00E+00	5.83E-05	0.00E+00	1.17E-04	1.39E-09	1.06E-06	1.85E-10	1.41E-07	1.23E-08	9.42E-06
Nb93m	0.00E+00	5.12E+00	0.00E+00	1.35E+02	0.00E+00	2.32E+01	1.16E-03	8.83E-01	3.85E-04	2.94E-01	4.62E-03	3.53E+00
Pu242	0.00E+00	5.73E-07	0.00E+00	8.18E-03	0.00E+00	2.60E-06	4.39E-04	3.35E-01	1.50E-05	1.15E-02	8.36E-05	6.38E-02
Th229	0.00E+00	2.83E-04	0.00E+00	3.93E-03	0.00E+00	1.28E-03	3.61E-09	2.75E-06	1.71E-08	1.30E-05	2.28E-08	1.74E-05
U233	0.00E+00	2.10E-04	0.00E+00	5.56E-04	0.00E+00	9.54E-04	1.86E-08	1.42E-05	7.67E-07	5.86E-04	2.33E-06	1.78E-03
Zr93	0.00E+00	5.65E-01	0.00E+00	8.44E+00	0.00E+00	2.56E+00	3.94E-04	3.01E-01	1.25E-02	9.51E+00	1.33E-02	1.01E+01

Notes:

(1) Estimated using transfer factors presented in Section 3.5.3.

(2) Estimated using transfer factors presented in Section 3.5.3, maximum estimated values based on water and sediment.

Table 3-4 Exposure Point Concentrations (Bq/kg FW) of Radiological COPCs in Consumed Foods Calculated Using Food Chain Modelling

Radiological COPCs	Canada Warbler		Purple Finch		Meadow Vole		Short-tailed Shrew		Eastern Whip-poor-will	White-tailed Deer
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Sitewide	Sitewide
(1) Normal Evolution Scenario and (9) Dose Optimization - Confidence in Land Use Restrictions										
Ac227	1.67E-08	1.51E-06	1.55E-08	1.24E-06	7.88E-08	9.30E-07	4.79E-08	3.34E-06	6.86E-09	8.25E-07
Mo93	1.03E-09	5.58E-06	9.54E-10	4.10E-06	4.04E-10	4.90E-07	2.46E-10	1.67E-06	1.96E-06	4.98E-07
Nb93m	2.61E-08	1.41E-02	2.42E-08	2.94E-03	1.60E-09	3.34E-05	9.74E-10	6.56E-04	4.91E-03	3.12E-05
Pu242	2.18E-09	3.20E-06	2.02E-09	2.22E-07	1.84E-10	2.70E-09	1.12E-10	2.15E-07	1.26E-06	2.35E-09
Th229	1.48E-11	1.66E-05	1.37E-11	1.13E-05	2.41E-11	2.60E-06	1.47E-11	1.46E-05	1.43E-06	2.28E-06
U233	7.51E-07	1.39E-03	6.97E-07	1.11E-03	2.76E-08	6.34E-06	1.68E-08	2.63E-05	7.57E-05	5.69E-06
Zr93	1.21E-08	6.88E-04	1.13E-08	4.63E-04	1.72E-08	9.27E-05	1.04E-08	5.28E-04	6.12E-05	8.10E-05
(1a) NES Sensitivity Analysis - Inventory Sensitivity										
Ac227	6.90E-08	1.46E-05	6.41E-08	1.20E-05	3.26E-07	8.62E-06	1.98E-07	3.23E-05	2.83E-08	7.59E-06
Am241	4.54E-06	9.25E-03	4.21E-06	9.06E-04	1.34E-04	3.75E-03	8.13E-05	2.14E-01	3.51E-03	3.25E-03
C14	8.10E+04	8.09E+03	8.09E+04	8.08E+03	6.67E+04	6.67E+03	6.67E+04	6.67E+03	4.45E+04	3.67E+04
Cl36	1.61E-02	5.91E-02	1.50E-02	5.77E+00	1.11E-02	1.39E+00	6.75E-03	2.93E-02	2.19E-02	1.43E+00
I129	4.46E-04	1.77E-01	4.14E-04	4.26E-02	2.43E-02	5.05E-01	1.48E-02	7.29E+00	6.15E-02	4.86E-01
Mo93	1.03E-08	5.58E-05	9.54E-09	4.10E-05	4.04E-09	4.90E-06	2.46E-09	1.67E-05	1.96E-05	4.98E-06
Nb93m	2.61E-07	1.41E-01	2.42E-07	2.94E-02	1.60E-08	3.34E-04	9.74E-09	6.56E-03	4.91E-02	3.12E-04
Po210	8.21E-03	5.97E+00	7.62E-03	3.86E+00	1.21E-03	2.13E-01	7.36E-04	4.79E-01	5.51E-01	2.06E-01
Pu239	2.98E-05	4.24E-02	2.77E-05	2.95E-03	2.52E-06	3.58E-05	1.53E-06	2.85E-03	1.67E-02	3.12E-05
Pu242	2.18E-08	3.20E-05	2.02E-08	2.22E-06	1.84E-09	2.70E-08	1.12E-09	2.15E-06	1.26E-05	2.35E-08
Ra226	5.09E-07	1.55E-01	4.73E-07	1.27E-01	2.04E-06	1.27E-01	1.24E-06	4.10E-01	3.60E-02	1.26E-01
Th228	7.96E-10	2.93E-02	7.39E-10	1.99E-02	1.30E-09	4.59E-03	7.88E-10	2.58E-02	2.52E-03	4.01E-03
Th229	3.08E-11	5.12E-05	2.86E-11	3.48E-05	5.01E-11	8.02E-06	3.05E-11	4.50E-05	4.41E-06	7.01E-06
U233	1.59E-06	2.83E-03	1.47E-06	2.24E-03	5.84E-08	1.29E-05	3.55E-08	5.34E-05	1.54E-04	1.15E-05
Zr93	1.21E-07	6.88E-03	1.13E-07	4.63E-03	1.72E-07	9.27E-04	1.04E-07	5.28E-03	6.12E-04	8.10E-04
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity										
Ac227	1.67E-08	1.51E-06	1.55E-08	1.24E-06	7.88E-08	9.30E-07	4.79E-08	3.34E-06	6.86E-09	8.25E-07
Mo93	1.03E-09	5.58E-06	9.54E-10	4.10E-06	4.04E-10	4.90E-07	2.46E-10	1.67E-06	1.96E-06	4.98E-07
Nb93m	2.61E-08	1.41E-02	2.42E-08	2.94E-03	1.60E-09	3.34E-05	9.74E-10	6.56E-04	4.91E-03	3.12E-05
Pu242	2.18E-09	3.20E-06	2.02E-09	2.22E-07	1.84E-10	2.70E-09	1.12E-10	2.15E-07	1.26E-06	2.35E-09
Th229	1.48E-11	1.66E-05	1.37E-11	1.13E-05	2.41E-11	2.60E-06	1.47E-11	1.46E-05	1.43E-06	2.28E-06
U233	7.51E-07	1.39E-03	6.97E-07	1.11E-03	2.76E-08	6.34E-06	1.68E-08	2.63E-05	7.57E-05	5.69E-06
Zr93	1.21E-08	6.88E-04	1.13E-08	4.63E-04	1.72E-08	9.27E-05	1.04E-08	5.28E-04	6.12E-05	8.10E-05
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity										
Ac227	8.40E-06	6.54E-08	6.92E-06	6.07E-08	3.09E-07	5.06E-06	1.88E-07	1.86E-05	2.69E-08	4.47E-06
Am241	1.90E-03	4.27E-06	1.89E-04	3.96E-06	1.26E-04	8.66E-04	7.66E-05	4.39E-02	7.20E-04	7.67E-04
C14	2.01E+03	8.10E+03	2.01E+03	8.09E+03	6.67E+03	1.66E+03	6.67E+03	1.65E+03	5.05E+03	4.16E+03
Cl36	4.00E-03	2.24E-03	2.38E-01	2.08E-03	1.54E-03	5.78E-02	9.38E-04	1.86E-03	1.55E-03	5.96E-02
Mo93	9.05E-06	2.88E-09	6.65E-06	2.67E-09	1.13E-09	7.95E-07	6.88E-10	2.70E-06	3.17E-06	8.08E-07
Nb93m	9.91E-02	2.77E-07	2.06E-02	2.57E-07	1.70E-08	2.34E-04	1.03E-08	4.60E-03	3.43E-02	2.19E-04
Po210	4.85E+00	6.76E-03	3.14E+00	6.27E-03	9.96E-04	1.73E-01	6.06E-04	3.90E-01	4.48E-01	1.68E-01
Pu239	6.70E-03	7.69E-06	4.68E-04	7.14E-06	6.50E-07	5.91E-06	3.96E-07	4.51E-04	2.64E-03	5.19E-06
Pu242	5.01E-06	5.61E-09	3.50E-07	5.21E-09	4.75E-10	4.41E-09	2.89E-10	3.37E-07	1.97E-06	3.87E-09
Ra226	1.27E-01	4.00E-07	1.04E-01	3.71E-07	1.60E-06	1.05E-01	9.76E-07	3.38E-01	2.96E-02	1.03E-01
Th228	2.93E-02	7.96E-10	1.99E-02	7.39E-10	1.30E-09	4.58E-03	7.88E-10	2.57E-02	2.52E-03	4.01E-03
Th229	4.73E-05	4.15E-11	3.21E-05	3.86E-11	6.76E-11	7.41E-06	4.11E-11	4.16E-05	4.07E-06	6.48E-06
Th232	2.94E-02	7.89E-10	1.99E-02	7.32E-10	1.28E-09	4.60E-03	7.81E-10	2.58E-02	2.53E-03	4.02E-03

Radiological COPCs	Canada Warbler		Purple Finch		Meadow Vole		Short-tailed Shrew		Eastern Whip-poor-will	White-tailed Deer
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Sitewide	Sitewide
U233	2.83E-03	1.83E-06	2.24E-03	1.70E-06	6.74E-08	1.29E-05	4.10E-08	5.34E-05	1.54E-04	1.16E-05
U234	6.97E-01	4.73E-04	5.53E-01	4.39E-04	1.74E-05	3.17E-03	1.06E-05	1.32E-02	3.79E-02	2.85E-03
Zr93	4.83E-03	2.82E-07	3.24E-03	2.62E-07	3.99E-07	6.50E-04	2.43E-07	3.70E-03	4.29E-04	5.68E-04
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek										
Ac227	1.75E-08	1.51E-06	1.62E-08	1.24E-06	8.25E-08	9.34E-07	5.02E-08	3.35E-06	7.18E-09	8.29E-07
Mo93	1.13E-09	5.58E-06	1.05E-09	4.10E-06	4.44E-10	4.90E-07	2.70E-10	1.67E-06	1.96E-06	4.98E-07
Nb93m	2.62E-08	1.41E-02	2.43E-08	2.94E-03	1.61E-09	3.34E-05	9.78E-10	6.56E-04	4.91E-03	3.12E-05
Pu242	2.37E-09	3.20E-06	2.20E-09	2.22E-07	2.00E-10	2.71E-09	1.22E-10	2.15E-07	1.26E-06	2.37E-09
Th229	1.53E-11	1.66E-05	1.42E-11	1.13E-05	2.49E-11	2.60E-06	1.51E-11	1.46E-05	1.43E-06	2.28E-06
U233	7.75E-07	1.39E-03	7.19E-07	1.11E-03	2.85E-08	6.34E-06	1.73E-08	2.63E-05	7.57E-05	5.69E-06
Zr93	1.18E-08	6.88E-04	1.10E-08	4.63E-04	1.68E-08	9.27E-05	1.02E-08	5.28E-04	6.12E-05	8.10E-05
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner										
Ac227	1.70E-08	3.29E-07	1.58E-08	2.72E-07	8.03E-08	2.58E-07	4.89E-08	7.37E-07	6.99E-09	2.37E-07
Mo93	9.51E-10	5.89E-06	8.83E-10	4.33E-06	3.74E-10	5.17E-07	2.27E-10	1.76E-06	2.06E-06	5.26E-07
Nb93m	1.17E-08	6.38E-03	1.08E-08	1.32E-03	7.16E-10	1.50E-05	4.36E-10	2.96E-04	2.21E-03	1.41E-05
Pu242	3.87E-09	9.75E-07	3.60E-09	7.05E-08	3.28E-10	1.09E-09	1.99E-10	6.56E-08	3.84E-07	9.90E-10
Th229	1.43E-11	2.29E-06	1.32E-11	1.55E-06	2.32E-11	3.59E-07	1.41E-11	2.01E-06	1.97E-07	3.14E-07
U233	7.36E-07	1.19E-03	6.83E-07	9.44E-04	2.71E-08	5.41E-06	1.65E-08	2.25E-05	6.46E-05	4.86E-06
Zr93	9.10E-09	3.09E-04	8.45E-09	2.07E-04	1.29E-08	4.16E-05	7.83E-09	2.37E-04	2.74E-05	3.63E-05
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER										
Ac227	1.53E-08	1.42E-06	1.42E-08	1.17E-06	7.22E-08	8.75E-07	4.39E-08	3.15E-06	6.28E-09	7.76E-07
Mo93	8.99E-10	5.33E-06	8.35E-10	3.92E-06	3.53E-10	4.68E-07	2.15E-10	1.59E-06	1.87E-06	4.76E-07
Nb93m	1.82E-08	1.13E-02	1.69E-08	2.35E-03	1.12E-09	2.67E-05	6.80E-10	5.25E-04	3.92E-03	2.50E-05
Pu242	1.80E-09	3.11E-06	1.67E-09	2.16E-07	1.53E-10	2.59E-09	9.28E-11	2.09E-07	1.22E-06	2.25E-09
Th229	1.34E-11	1.06E-05	1.24E-11	7.19E-06	2.18E-11	1.66E-06	1.32E-11	9.30E-06	9.11E-07	1.45E-06
U233	6.67E-07	1.32E-03	6.19E-07	1.05E-03	2.45E-08	6.02E-06	1.49E-08	2.50E-05	7.20E-05	5.40E-06
Zr93	9.18E-09	5.50E-04	8.53E-09	3.70E-04	1.30E-08	7.42E-05	7.90E-09	4.22E-04	4.89E-05	6.48E-05
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)										
Ac227	7.24E-08	1.51E-06	6.14E-08	1.24E-06	1.11E-07	9.30E-07	1.71E-07	3.34E-06	6.86E-09	8.53E-07
Mo93	7.65E-08	5.58E-06	5.64E-08	4.10E-06	7.03E-09	4.90E-07	2.28E-08	1.67E-06	1.98E-06	5.04E-07
Nb93m	4.14E-04	1.41E-02	8.59E-05	2.94E-03	9.77E-07	3.34E-05	1.92E-05	6.56E-04	5.05E-03	3.21E-05
Pu242	3.96E-07	3.20E-06	2.91E-08	2.22E-07	4.93E-10	2.70E-09	2.66E-08	2.15E-07	1.41E-06	2.61E-09
Th229	1.20E-07	1.66E-05	8.15E-08	1.13E-05	1.88E-08	2.60E-06	1.06E-07	1.46E-05	1.44E-06	2.29E-06
U233	1.33E-04	1.39E-03	1.06E-04	1.11E-03	6.26E-07	6.34E-06	2.51E-06	2.63E-05	8.29E-05	6.22E-06
Zr93	2.04E-05	6.88E-04	1.37E-05	4.63E-04	2.76E-06	9.27E-05	1.56E-05	5.28E-04	6.30E-05	8.34E-05
(4) Disruptive Event - Enhanced Erosion Case										
Ac227	5.84E-08	7.43E-06	5.42E-08	6.12E-06	2.75E-07	4.48E-06	1.67E-07	1.65E-05	2.40E-08	3.96E-06
Mo93	9.27E-10	4.68E-06	8.61E-10	3.44E-06	3.65E-10	4.11E-07	2.22E-10	1.40E-06	1.64E-06	4.17E-07
Nb93m	2.23E-07	6.38E-03	2.07E-07	1.33E-03	1.37E-08	1.51E-05	8.31E-09	2.96E-04	2.21E-03	1.41E-05
Pu242	8.70E-10	2.29E-06	8.07E-10	1.59E-07	7.36E-11	1.87E-09	4.48E-11	1.54E-07	9.03E-07	1.62E-09
Th229	2.26E-10	1.25E-05	2.10E-10	8.47E-06	3.68E-10	1.96E-06	2.24E-10	1.10E-05	1.07E-06	1.71E-06
U233	9.37E-07	9.00E-04	8.70E-07	7.14E-04	3.45E-08	4.11E-06	2.10E-08	1.70E-05	4.90E-05	3.69E-06
Zr93	4.77E-08	3.06E-04	4.43E-08	2.06E-04	6.75E-08	4.13E-05	4.10E-08	2.35E-04	2.72E-05	3.61E-05
(5) Disruptive Event - Localized Cover Failure										
Ac227	1.65E-08	1.38E-06	1.54E-08	1.14E-06	7.80E-08	8.57E-07	4.74E-08	3.06E-06	6.79E-09	7.61E-07
Mo93	8.83E-10	3.98E-06	8.20E-10	2.93E-06	3.47E-10	3.50E-07	2.11E-10	1.19E-06	1.40E-06	3.56E-07
Nb93m	3.01E-08	1.51E-02	2.79E-08	3.14E-03	1.84E-09	3.57E-05	1.12E-09	7.02E-04	5.25E-03	3.34E-05
Pu242	1.86E-09	1.70E-06	1.72E-09	1.19E-07	1.57E-10	1.49E-09	9.55E-11	1.15E-07	6.70E-07	1.31E-09

Radiological COPCs	Canada Warbler		Purple Finch		Meadow Vole		Short-tailed Shrew		Eastern Whip-poor-will	White-tailed Deer
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Sitewide	Sitewide
Th229	1.49E-11	1.67E-05	1.38E-11	1.13E-05	2.43E-11	2.62E-06	1.47E-11	1.47E-05	1.44E-06	2.29E-06
U233	7.47E-07	1.37E-03	6.93E-07	1.09E-03	2.75E-08	6.24E-06	1.67E-08	2.59E-05	7.46E-05	5.61E-06
Zr93	1.35E-08	7.37E-04	1.26E-08	4.95E-04	1.92E-08	9.93E-05	1.17E-08	5.65E-04	6.55E-05	8.67E-05
(6) Disruptive Event - Localized Liner Failure										
Ac227	1.78E-08	1.26E-06	1.65E-08	1.03E-06	8.38E-08	7.90E-07	5.10E-08	2.78E-06	7.29E-09	7.03E-07
Mo93	1.25E-09	4.75E-06	1.16E-09	3.50E-06	4.91E-10	4.18E-07	2.99E-10	1.42E-06	1.67E-06	4.24E-07
Nb93m	3.86E-08	1.07E-02	3.58E-08	2.23E-03	2.37E-09	2.53E-05	1.44E-09	4.98E-04	3.72E-03	2.37E-05
Pu242	2.34E-09	2.60E-06	2.17E-09	1.81E-07	1.98E-10	2.24E-09	1.20E-10	1.75E-07	1.02E-06	1.96E-09
Th229	1.45E-11	1.17E-05	1.34E-11	7.93E-06	2.35E-11	1.83E-06	1.43E-11	1.03E-05	1.00E-06	1.60E-06
U233	8.94E-07	1.22E-03	8.30E-07	9.68E-04	3.29E-08	5.55E-06	2.00E-08	2.30E-05	6.64E-05	4.99E-06
Zr93	4.35E-08	5.22E-04	4.04E-08	3.51E-04	6.16E-08	7.04E-05	3.75E-08	4.01E-04	4.64E-05	6.15E-05
(7) Disruptive Event - Damage to Berm										
Ac227	1.75E-08	2.03E-06	1.62E-08	1.67E-06	8.25E-08	1.23E-06	5.02E-08	4.49E-06	7.18E-09	1.09E-06
Mo93	1.56E-09	7.75E-06	1.44E-09	5.70E-06	6.12E-10	6.81E-07	3.72E-10	2.31E-06	2.72E-06	6.92E-07
Nb93m	3.07E-08	1.69E-02	2.85E-08	3.50E-03	1.88E-09	3.98E-05	1.15E-09	7.82E-04	5.85E-03	3.72E-05
Pu242	2.22E-09	5.44E-06	2.07E-09	3.77E-07	1.88E-10	4.46E-09	1.14E-10	3.66E-07	2.14E-06	3.87E-09
Th229	1.52E-11	2.17E-05	1.41E-11	1.47E-05	2.48E-11	3.39E-06	1.51E-11	1.90E-05	1.86E-06	2.97E-06
U233	7.19E-07	1.50E-03	6.68E-07	1.19E-03	2.65E-08	6.81E-06	1.61E-08	2.83E-05	8.13E-05	6.11E-06
Zr93	1.28E-08	8.21E-04	1.19E-08	5.52E-04	1.81E-08	1.11E-04	1.10E-08	6.30E-04	7.29E-05	9.66E-05
(8) Dose Optimization - Wastes Grouted into Steel Liners										
Ac227	1.62E-08	1.51E-06	1.50E-08	1.24E-06	7.63E-08	9.29E-07	4.64E-08	3.35E-06	6.64E-09	8.23E-07
Mo93	1.03E-09	5.58E-06	9.55E-10	4.10E-06	4.04E-10	4.90E-07	2.46E-10	1.67E-06	1.96E-06	4.98E-07
Nb93m	2.61E-08	1.42E-02	2.43E-08	2.94E-03	1.60E-09	3.34E-05	9.75E-10	6.57E-04	4.91E-03	3.13E-05
Pu242	2.18E-09	3.20E-06	2.03E-09	2.22E-07	1.85E-10	2.70E-09	1.12E-10	2.16E-07	1.26E-06	2.35E-09
Th229	1.48E-11	1.66E-05	1.38E-11	1.13E-05	2.41E-11	2.61E-06	1.47E-11	1.46E-05	1.43E-06	2.28E-06
U233	7.51E-07	1.39E-03	6.98E-07	1.11E-03	2.76E-08	6.34E-06	1.68E-08	2.63E-05	7.58E-05	5.69E-06
Zr93	1.21E-08	6.89E-04	1.13E-08	4.63E-04	1.72E-08	9.28E-05	1.04E-08	5.29E-04	6.12E-05	8.11E-05
(11) Defence-in-Depth - Role of Geosphere										
Ac227	8.32E-08	1.58E-06	7.72E-08	1.30E-06	3.92E-07	1.24E-06	2.39E-07	3.54E-06	3.42E-08	1.15E-06
Mo93	1.21E-09	5.58E-06	1.12E-09	4.10E-06	4.75E-10	4.90E-07	2.89E-10	1.67E-06	1.96E-06	4.98E-07
Nb93m	9.60E-08	1.41E-02	8.91E-08	2.94E-03	5.88E-09	3.34E-05	3.58E-09	6.56E-04	4.91E-03	3.12E-05
Pu242	2.66E-09	3.20E-06	2.47E-09	2.23E-07	2.25E-10	2.74E-09	1.37E-10	2.15E-07	1.26E-06	2.39E-09
Th229	7.86E-11	1.66E-05	7.29E-11	1.13E-05	1.28E-10	2.60E-06	7.78E-11	1.46E-05	1.43E-06	2.28E-06
U233	7.91E-07	1.39E-03	7.35E-07	1.11E-03	2.91E-08	6.34E-06	1.77E-08	2.63E-05	7.57E-05	5.69E-06
Zr93	1.22E-08	6.88E-04	1.13E-08	4.63E-04	1.72E-08	9.27E-05	1.05E-08	5.28E-04	6.12E-05	8.10E-05
(12) Defence-in-Depth - Role of Cover										
Ac227	1.69E-08	1.35E-06	1.57E-08	1.11E-06	7.99E-08	8.40E-07	4.86E-08	2.99E-06	6.96E-09	7.47E-07
Mo93	1.14E-09	6.34E-06	1.06E-09	4.66E-06	4.47E-10	5.57E-07	2.72E-10	1.89E-06	2.22E-06	5.66E-07
Nb93m	4.18E-08	1.93E-02	3.88E-08	4.02E-03	2.56E-09	4.56E-05	1.56E-09	8.97E-04	6.71E-03	4.27E-05
Pu242	6.27E-09	8.02E-07	5.82E-09	6.06E-08	5.30E-10	1.16E-09	3.23E-10	5.39E-08	3.16E-07	1.08E-09
Th229	1.53E-11	1.81E-05	1.42E-11	1.23E-05	2.50E-11	2.83E-06	1.52E-11	1.59E-05	1.56E-06	2.48E-06
U233	7.55E-07	1.44E-03	7.01E-07	1.15E-03	2.78E-08	6.57E-06	1.69E-08	2.73E-05	7.85E-05	5.89E-06
Zr93	1.83E-08	9.42E-04	1.70E-08	6.33E-04	2.60E-08	1.27E-04	1.58E-08	7.23E-04	8.37E-05	1.11E-04
(13) Defence-in-Depth - Role of Base Liner										
Ac227	2.22E-08	2.23E-08	2.07E-08	2.07E-08	1.05E-07	1.05E-07	6.38E-08	6.40E-08	9.13E-09	1.07E-07
Mo93	1.85E-09	1.95E-09	1.72E-09	1.79E-09	7.28E-10	7.37E-10	4.43E-10	4.71E-10	7.94E-10	7.51E-10
Nb93m	4.02E-08	4.34E-07	3.73E-08	1.19E-07	2.46E-09	3.39E-09	1.50E-09	1.98E-08	1.53E-07	3.38E-09
Pu242	1.92E-09	1.96E-09	1.78E-09	1.79E-09	1.62E-10	1.63E-10	9.88E-11	1.02E-10	8.04E-10	1.66E-10

Radiological COPCs	Canada Warbler		Purple Finch		Meadow Vole		Short-tailed Shrew		Eastern Whip-poor-will	White-tailed Deer
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Sitewide	Sitewide
Th229	1.76E-11	1.57E-10	1.64E-11	1.11E-10	2.87E-11	5.06E-11	1.75E-11	1.40E-10	1.93E-11	4.84E-11
U233	9.02E-07	9.28E-07	8.37E-07	8.58E-07	3.32E-08	3.33E-08	2.02E-08	2.07E-08	3.72E-07	3.39E-08
Zr93	4.85E-08	6.79E-08	4.50E-08	5.81E-08	6.86E-08	7.12E-08	4.17E-08	5.66E-08	2.16E-08	7.22E-08
(14) Defence-in-Depth - Series of Landslides										
Ac227	4.06E-08	3.83E-06	3.77E-08	3.15E-06	1.92E-07	2.35E-06	1.17E-07	8.48E-06	1.67E-08	2.09E-06
Mo93	1.64E-09	5.11E-06	1.52E-09	3.76E-06	6.45E-10	4.49E-07	3.92E-10	1.53E-06	1.79E-06	4.56E-07
Nb93m	1.17E-06	1.17E-02	1.08E-06	2.43E-03	7.15E-08	2.76E-05	4.35E-08	5.42E-04	4.05E-03	2.58E-05
Pu242	2.18E-09	5.44E-06	2.02E-09	3.76E-07	1.84E-10	4.46E-09	1.12E-10	3.66E-07	2.14E-06	3.86E-09
Th229	8.63E-10	9.43E-06	8.01E-10	6.40E-06	1.40E-09	1.48E-06	8.54E-10	8.28E-06	8.12E-07	1.29E-06
U233	2.44E-06	2.51E-03	2.27E-06	1.99E-03	8.99E-08	1.14E-05	5.47E-08	4.73E-05	1.37E-04	1.03E-05
Zr93	2.56E-07	5.87E-04	2.37E-07	3.95E-04	3.62E-07	7.94E-05	2.20E-07	4.50E-04	5.22E-05	6.94E-05
(15) What If - Human Intrusion, Mass Excavation and Farming										
Ac227	8.44E-07	2.42E-06	7.00E-07	2.00E-06	7.17E-07	1.62E-06	1.90E-06	5.39E-06	2.33E-08	1.85E-06
Am241	4.36E-03	7.96E-03	4.31E-04	7.82E-04	1.92E-03	3.33E-03	1.01E-01	1.84E-01	4.67E-03	4.37E-03
C14	8.10E+03	3.49E+04	8.09E+03	3.49E+04	6.68E+03	2.88E+04	6.67E+03	2.88E+04	2.15E+04	1.77E+04
Cl36	5.89E-03	1.24E-02	3.76E-02	9.07E-01	1.16E-02	2.19E-01	2.49E-03	5.90E-03	4.80E-03	2.34E-01
Mo93	1.18E-06	5.79E-06	8.68E-07	4.26E-06	1.04E-07	5.09E-07	3.52E-07	1.73E-06	2.44E-06	6.22E-07
Nb93m	5.24E-03	2.05E-02	1.09E-03	4.25E-03	1.24E-05	4.83E-05	2.43E-04	9.49E-04	8.91E-03	5.68E-05
Po210	6.46E-01	1.01E+00	4.38E-01	6.74E-01	3.12E-02	4.41E-02	5.26E-02	8.19E-02	1.69E-01	6.30E-02
Pu239	2.95E-03	6.38E-03	2.16E-04	4.52E-04	3.52E-06	6.21E-06	1.99E-04	4.29E-04	3.67E-03	7.53E-06
Pu242	2.34E-06	5.05E-06	1.71E-07	3.57E-07	2.79E-09	4.92E-09	1.57E-07	3.40E-07	2.90E-06	5.96E-09
Ra226	1.87E-02	2.45E-02	1.53E-02	2.01E-02	1.54E-02	2.01E-02	4.96E-02	6.50E-02	1.01E-02	3.51E-02
Th228	3.35E-03	2.07E-02	2.27E-03	1.40E-02	5.25E-04	3.23E-03	2.94E-03	1.81E-02	2.07E-03	3.29E-03
Th229	7.47E-07	2.17E-05	5.07E-07	1.47E-05	1.17E-07	3.40E-06	6.56E-07	1.91E-05	1.93E-06	3.07E-06
U233	1.26E-03	1.87E-03	9.97E-04	1.48E-03	5.73E-06	8.50E-06	2.37E-05	3.53E-05	1.70E-04	1.27E-05
Zr93	2.56E-04	1.04E-03	1.72E-04	6.99E-04	3.46E-05	1.40E-04	1.96E-04	7.98E-04	1.15E-04	1.53E-04
(17) What If - Permanent Bathtub										
Ac227	4.92E-08	4.37E-06	4.57E-08	3.60E-06	2.32E-07	2.69E-06	1.41E-07	9.68E-06	2.02E-08	2.39E-06
Mo93	1.05E-09	5.61E-06	9.74E-10	4.13E-06	4.12E-10	4.93E-07	2.51E-10	1.68E-06	1.97E-06	5.01E-07
Nb93m	1.31E-07	2.19E-02	1.22E-07	4.55E-03	8.04E-09	5.16E-05	4.89E-09	1.02E-03	7.59E-03	4.83E-05
Pu242	2.18E-09	3.58E-06	2.02E-09	2.49E-07	1.84E-10	3.00E-09	1.12E-10	2.41E-07	1.41E-06	2.61E-09
Th229	2.15E-11	8.56E-05	2.00E-11	5.81E-05	3.50E-11	1.34E-05	2.13E-11	7.52E-05	7.37E-06	1.17E-05
U233	6.59E-07	1.44E-03	6.12E-07	1.14E-03	2.43E-08	6.55E-06	1.48E-08	2.72E-05	7.83E-05	5.88E-06
Zr93	2.82E-08	1.07E-03	2.62E-08	7.17E-04	4.00E-08	1.44E-04	2.43E-08	8.18E-04	9.48E-05	1.26E-04

Table 3-5 Exposure Point Concentrations of Non-radiological COPCs in Environmental Media

Non-Radiological COPCs	Perch Creek Surface Water[1] (µg/L)	Ottawa River Surface Water (µg/L)	Garden Area Soil (mg/kg)	Grazing Area Soil (mg/kg)	Perch Creek Sediment (mg/kg)	Ottawa River Sediment (mg/kg)
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization – Confidence in Land Use Restrictions						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.42E+00	3.00E+00	5.20E+01	6.60E+01	6.05E+01	1.00E+01
Uranium (U)	2.19E-01	2.08E-16	1.50E+00	3.70E+00	1.22E+00	1.30E+00
(1a) NES Sensitivity Analysis - Inventory Sensitivity						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.42E+00	3.00E+00	5.20E+01	6.60E+01	6.05E+01	1.00E+01
Uranium (U)	3.85E-01	4.25E-04	1.50E+00	5.97E+00	1.46E+00	1.30E+00
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.42E+00	3.00E+00	5.20E+01	6.60E+01	6.05E+01	1.00E+01
Uranium (U)	2.19E-01	2.08E-04	1.50E+00	3.70E+00	1.22E+00	1.30E+00
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.77E+00	3.00E+00	5.20E+01	6.60E+01	6.22E+01	1.00E+01
Uranium (U)	4.42E-01	5.00E-04	1.50E+00	5.97E+00	1.52E+00	1.30E+00
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.43E+00	3.00E+00	5.20E+01	6.60E+01	6.07E+01	1.00E+01
Uranium (U)	2.23E-01	2.14E-04	1.50E+00	3.70E+00	1.22E+00	1.30E+00
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.16E+00	3.00E+00	5.20E+01	6.41E+01	6.05E+01	1.00E+01
Uranium (U)	2.17E-01	2.05E-04	1.50E+00	3.37E+00	1.23E+00	1.30E+00
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.35E+00	3.00E+00	5.20E+01	6.53E+01	6.03E+01	1.00E+01
Uranium (U)	2.04E-01	1.88E-04	1.50E+00	3.59E+00	1.21E+00	1.30E+00
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.42E+00	3.00E+00	5.20E+01	6.60E+01	6.05E+01	1.00E+01
Uranium (U)	2.19E-01	2.08E-04	1.70E+00	3.70E+00	1.22E+00	1.30E+00
(4) Disruptive Event - Enhanced Erosion Case						
Aluminum (Al)	2.44E+02	2.09E+02	ND[2]	ND[2]	4.20E+01	4.20E+01
Copper (Cu)	3.97E+01	3.05E+00	ND	1.80E+03	1.56E+01	2.00E+01
Lead (Pb)	1.03E+01	3.00E+00	ND	1.31E+02	6.16E+01	1.00E+01
Uranium (U)	2.57E-01	2.58E-04	ND	2.93E+00	1.25E+00	1.30E+00
(5) Disruptive Event - Localized Cover Failure						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.43E+00	3.00E+00	5.20E+01	6.60E+01	6.06E+01	1.00E+01
Uranium (U)	2.18E-01	2.07E-04	1.50E+00	3.67E+00	1.22E+00	1.30E+00
(6) Disruptive Event - Localized Liner Failure						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.30E+00	3.00E+00	5.20E+01	6.43E+01	6.06E+01	1.00E+01
Uranium (U)	2.51E-01	2.50E-04	1.50E+00	3.43E+00	1.27E+00	1.30E+00

Non-Radiological COPCs	Perch Creek Surface Water[1] (µg/L)	Ottawa River Surface Water (µg/L)	Garden Area Soil (mg/kg)	Grazing Area Soil (mg/kg)	Perch Creek Sediment (mg/kg)	Ottawa River Sediment (mg/kg)
(7) Disruptive Event - Damage to Berm						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.47E+00	3.00E+00	5.20E+01	6.66E+01	6.06E+01	1.00E+01
Uranium (U)	2.12E-01	1.99E-04	1.50E+00	4.13E+00	1.21E+00	1.30E+00
(8) Dose Optimization - Waste Packages - Wastes Grouted into Steel Liners						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.42E+00	3.00E+00	5.20E+01	6.60E+01	6.05E+01	1.00E+01
Uranium (U)	2.08E-01	1.94E-04	1.50E+00	3.70E+00	1.21E+00	1.30E+00
(11) Defence-in-Depth - Role of Geosphere						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.89E+00	3.00E+00	5.20E+01	6.60E+01	6.19E+01	1.00E+01
Uranium (U)	2.27E-01	2.19E-04	1.50E+00	3.70E+00	1.25E+00	1.30E+00
(12) Defence-in-Depth - Role of Cover						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.45E+00	3.00E+00	5.20E+01	6.64E+01	6.06E+01	1.00E+01
Uranium (U)	2.20E-01	2.10E-04	1.50E+00	3.78E+00	1.22E+00	1.30E+00
(13) Defence-in-Depth - Role of Base Liner						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.26E+00	3.00E+00	5.20E+01	5.20E+01	6.08E+01	1.00E+01
(14) Defence-in-Depth - Series of Landslides						
Aluminum (Al)	3.27E+05	6.38E+02	ND[2]	ND[2]	4.20E+01	4.20E+01
Copper (Cu)	2.05E+02	3.29E+00	ND	5.61E+03	2.00E+01	2.02E+01
Lead (Pb)	1.89E+01	3.01E+00	ND	1.53E+02	6.38E+01	1.00E+01
Copper (Cu)	5.48E-01	6.46E-04	ND	5.57E+00	1.21E+00	1.30E+00
(15) What If - Human Intrusion, Mass Excavation and Farming						
Copper (Cu)	4.21E+00	3.00E+00	1.19E+03	1.11E+03	1.50E+01	2.00E+01
Lead (Pb)	1.03E+01	3.00E+00	1.11E+02	1.03E+02	6.55E+01	1.00E+01
Copper (Cu)	4.13E-01	4.62E-04	4.77E+00	6.36E+00	1.48E+00	1.30E+00
(17) What If - Permanent Bathtub						
Copper (Cu)	4.20E+00	3.00E+00	2.20E+01	2.20E+01	1.50E+01	2.00E+01
Lead (Pb)	8.90E+00	3.00E+00	5.20E+01	6.66E+01	6.17E+01	1.00E+01
Copper (Cu)	1.89E-01	1.69E-04	1.50E+00	3.78E+00	1.15E+00	1.30E+00

Notes:
Exposure Point Concentration – maximum predicted concentration over the entire PostSA assessment timeframe (10,000 years) with added background.
(1) For scenarios (4) and (14) - Waste materials move downslope into the creek forming suspended sediment. Solubility limits are not applied in the creek, therefore dissolution of contaminants from the suspended sediment and contaminant concentrations in the creek water are likely to be overestimated.
(2) A very high inventory derived based on an estimated number of waste packages is used for aluminum, with releases from the ECM in water being soluble. The concentration in the swamp soils due to landslides and downslope movement of the wastes depends on the very high inventory and therefore the result is meaningless.
ND - Not Determined.

Table 3-6 Exposure Point Concentrations (mg/kg FW) of Non-Radiological COPCs in Consumed Foods Calculated Using Transfer Factors

Non-Radiological COPCs	Terrestrial Vegetation [1]		Earthworm [1]		Seeds [1]		Fish [1]		Benthic Invertebrates [2]		Aquatic Vegetation [1]	
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Ottawa River	Perch Creek	Ottawa River	Perch Creek	Ottawa River	Perch Creek
(1) Normal Evolution Scenario and (9) Dose Optimization - Confidence in Land Use Restrictions												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.11E+00	9.60E-02	5.81E-01	5.70E+00	1.60E+01
Uranium (U)	3.00E-03	7.40E-03	7.92E-03	1.95E-02	1.36E-02	3.36E-02	5.00E-19	5.26E-04	2.21E-02	2.17E-02	6.25E-17	6.57E-02
(1a) NES Sensitivity Analysis - Inventory Sensitivity												
Copper (Cu)	3.52E+00	3.53E+00	3.52E+00	3.53E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	3.22E+00	4.09E+00	2.50E-01	3.17E-01	1.11E+00	3.11E+00	9.60E-02	5.81E-01	5.70E+00	1.60E+01
Uranium (U)	3.00E-03	1.19E-02	3.00E-03	1.19E-02	1.36E-02	5.41E-02	1.02E-06	9.23E-04	2.21E-02	3.81E-02	1.28E-04	1.15E-01
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.11E+00	9.60E-02	5.81E-01	5.70E+00	1.60E+01
Uranium (U)	3.00E-03	7.40E-03	7.92E-03	1.95E-02	1.36E-02	3.36E-02	5.00E-07	5.26E-04	2.21E-02	2.17E-02	6.25E-05	6.57E-02
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.24E+00	9.60E-02	5.97E-01	5.70E+00	1.67E+01
Uranium (U)	3.00E-03	1.19E-02	7.92E-03	3.15E-02	1.36E-02	5.41E-02	1.20E-06	1.06E-03	2.21E-02	4.38E-02	1.50E-04	1.33E-01
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.12E+00	9.60E-02	5.83E-01	5.70E+00	1.60E+01
Uranium (U)	3.00E-03	7.40E-03	7.92E-03	1.95E-02	1.36E-02	3.36E-02	5.14E-07	5.36E-04	2.21E-02	2.21E-02	6.42E-05	6.70E-02
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner												
Copper (Cu)	3.52E+00	3.52E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	3.97E+00	2.58E+00	3.18E+00	2.50E-01	3.08E-01	1.11E+00	3.02E+00	9.60E-02	5.80E-01	5.70E+00	1.55E+01
Uranium (U)	3.00E-03	6.75E-03	7.92E-03	1.78E-02	1.36E-02	3.06E-02	4.92E-07	5.20E-04	2.21E-02	2.14E-02	6.15E-05	6.50E-02
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.05E+00	2.58E+00	3.24E+00	2.50E-01	3.14E-01	1.11E+00	3.09E+00	9.60E-02	5.79E-01	5.70E+00	1.59E+01
Uranium (U)	3.00E-03	7.18E-03	7.92E-03	1.90E-02	1.36E-02	3.26E-02	4.51E-07	4.89E-04	2.21E-02	2.06E-02	5.64E-05	6.11E-02
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.11E+00	9.60E-02	5.81E-01	5.70E+00	1.60E+01
Uranium (U)	3.41E-03	7.40E-03	8.99E-03	1.95E-02	1.54E-02	3.36E-02	5.00E-07	5.26E-04	2.21E-02	2.17E-02	6.25E-05	6.57E-02
(4) Disruptive Event - Enhanced Erosion Case [3]												
Aluminum (Al)	-	-	-	-	-	-	1.38E+01	1.61E+01	7.11E+02	8.31E+02	8.72E+01	1.02E+02
Copper (Cu)	-	2.87E+02	-	1.35E+02	-	1.30E+03	8.23E-01	1.07E+01	9.41E+00	7.34E+00	9.14E+00	1.19E+02
Lead (Pb)	-	8.11E+00	-	6.49E+00	-	6.29E-01	1.11E+00	3.81E+00	9.60E-02	5.92E-01	5.71E+00	1.95E+01
Uranium (U)	-	5.86E-03	-	1.55E-02	-	2.66E-02	6.19E-07	6.16E-04	2.21E-02	2.54E-02	7.74E-05	7.70E-02
(5) Disruptive Event - Localized Cover Failure												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.28E+00	2.50E-01	3.17E-01	1.11E+00	3.12E+00	9.60E-02	5.81E-01	5.70E+00	1.60E+01
Uranium (U)	3.00E-03	7.34E-03	7.92E-03	1.94E-02	1.36E-02	3.33E-02	4.97E-07	5.24E-04	2.21E-02	2.16E-02	6.22E-05	6.55E-02
(6) Disruptive Event - Localized Liner Failure												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	3.98E+00	2.58E+00	3.19E+00	2.50E-01	3.09E-01	1.11E+00	3.07E+00	9.60E-02	5.82E-01	5.70E+00	1.58E+01
Uranium (U)	3.00E-03	6.85E-03	7.92E-03	1.81E-02	1.36E-02	3.11E-02	5.99E-07	6.01E-04	2.21E-02	2.48E-02	7.49E-05	7.52E-02

Non-Radiological COPCs	Terrestrial Vegetation [1]		Earthworm [1]		Seeds [1]		Fish [1]		Benthic Invertebrates [2]		Aquatic Vegetation [1]	
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Ottawa River	Perch Creek	Ottawa River	Perch Creek	Ottawa River	Perch Creek
(7) Disruptive Event - Damage to Berm												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.13E+00	2.58E+00	3.30E+00	2.50E-01	3.20E-01	1.11E+00	3.14E+00	9.60E-02	5.82E-01	5.70E+00	1.61E+01
Uranium (U)	3.00E-03	8.26E-03	7.92E-03	2.18E-02	1.36E-02	3.75E-02	4.78E-07	5.09E-04	2.21E-02	2.10E-02	5.98E-05	6.37E-02
(8) Dose Optimization - Wastes Grouted into Steel Liners												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.11E+00	9.60E-02	5.81E-01	5.70E+00	1.60E+01
Uranium (U)	3.00E-03	7.40E-03	7.92E-03	1.95E-02	1.36E-02	3.36E-02	4.64E-07	4.99E-04	2.21E-02	2.06E-02	5.81E-05	6.23E-02
(11) Defence-in-Depth - Role of Geosphere												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.06E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.09E+00	2.58E+00	3.27E+00	2.50E-01	3.17E-01	1.11E+00	3.29E+00	9.60E-02	5.94E-01	5.70E+00	1.69E+01
Uranium (U)	3.00E-03	7.40E-03	7.92E-03	1.95E-02	1.36E-02	3.36E-02	5.26E-07	5.45E-04	2.21E-02	2.25E-02	6.57E-05	6.82E-02
(12) Defence-in-Depth - Role of Cover												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.12E+00	2.58E+00	3.29E+00	2.50E-01	3.19E-01	1.11E+00	3.13E+00	9.60E-02	5.82E-01	5.70E+00	1.61E+01
Uranium (U)	3.00E-03	7.55E-03	7.92E-03	1.99E-02	1.36E-02	3.43E-02	5.04E-07	5.29E-04	2.21E-02	2.18E-02	6.30E-05	6.61E-02
(13) Defence-in-Depth - Role of Base Liner												
Copper (Cu)	3.52E+00	3.52E+00	1.65E+00	1.65E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	3.22E+00	2.58E+00	2.58E+00	2.50E-01	2.50E-01	1.11E+00	3.06E+00	9.60E-02	5.83E-01	5.70E+00	1.57E+01
Uranium (U)	3.00E-03	3.00E-03	7.92E-03	7.92E-03	1.36E-02	1.36E-02	6.07E-07	6.08E-04	2.21E-02	2.51E-02	7.59E-05	7.60E-02
(14) Defence-in-Depth - Series of Landslides [3]												
Aluminum (Al)	-	-	-	-	-	-	4.21E+01	2.16E+04	2.17E+03	1.11E+06	2.66E+02	1.37E+05
Copper (Cu)	-	8.98E+02	-	4.22E+02	-	4.07E+03	8.88E-01	5.54E+01	9.47E+00	9.41E+00	9.87E+00	6.15E+02
Lead (Pb)	-	9.47E+00	-	7.58E+00	-	7.35E-01	1.12E+00	6.98E+00	9.60E-02	6.13E-01	5.73E+00	3.59E+01
Uranium (U)	-	1.11E-02	-	2.94E-02	-	5.05E-02	1.55E-06	1.32E-03	2.21E-02	5.43E-02	1.94E-04	1.64E-01
(15) What If - Human Intrusion, Mass Excavation and Farming												
Copper (Cu)	1.90E+02	1.78E+02	8.95E+01	8.35E+01	8.63E+02	8.05E+02	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	6.88E+00	6.39E+00	5.51E+00	5.11E+00	5.34E-01	4.95E-01	1.11E+00	3.60E+00	9.60E-02	6.24E-01	5.70E+00	1.85E+01
Uranium (U)	9.54E-03	1.25E-02	2.52E-02	3.31E-02	4.33E-02	5.69E-02	9.91E-07	9.00E-04	2.21E-02	3.71E-02	1.24E-04	1.13E-01
(17) What If - Permanent Bathtub												
Copper (Cu)	3.52E+00	3.53E+00	1.65E+00	1.66E+00	1.60E+01	1.60E+01	8.10E-01	1.13E+00	9.40E+00	7.05E+00	9.00E+00	1.26E+01
Lead (Pb)	3.22E+00	4.13E+00	2.58E+00	3.30E+00	2.50E-01	3.20E-01	1.11E+00	3.29E+00	9.60E-02	5.92E-01	5.70E+00	1.69E+01
Uranium (U)	3.00E-03	7.55E-03	7.92E-03	1.99E-02	1.36E-02	3.43E-02	4.05E-07	4.53E-04	2.21E-02	1.95E-02	5.06E-05	5.67E-02

Notes:

(1) Estimated using transfer factors presented in Section 3.5.3

(2) Estimated using transfer factors presented in Section 3.5.3, maximum estimated values based on water and sediment.

(3) For Scenarios (4) and (14) aluminum concentrations were not predicted in the Garden Area and Grazing Area and copper, lead and uranium in the Garden Area.

Table 3-7 Exposure Point Concentrations (mg/kg FW) of Non-Radiological COPCs in Consumed Foods Calculated Using Food Chain Modelling

Non-Radiological COPCs	Purple Finch [2]		Meadow Vole [2]		Short-tailed Shrew [2]		Eastern Whip-poor-will [2]	White-tailed Deer [2]
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Sitewide	Sitewide
(1) Normal Evolution Scenario and (9) Dose Optimization - Confidence in Land Use Restrictions								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.52E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	4.02E-02	9.40E-05	2.30E-04	3.89E-04	9.58E-04	3.87E-03	2.90E-04
(1a) NES Sensitivity Analysis - Inventory Sensitivity								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.52E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	6.49E-02	9.46E-05	3.72E-04	3.89E-04	1.54E-03	5.55E-03	4.17E-04
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.52E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	4.02E-02	9.40E-05	2.30E-04	3.89E-04	9.58E-04	3.87E-03	2.90E-04
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.53E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	6.49E-02	9.49E-05	3.72E-04	3.89E-04	1.54E-03	5.56E-03	4.17E-04
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.52E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	4.02E-02	9.40E-05	2.30E-04	3.89E-04	9.58E-04	3.87E-03	2.90E-04
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.10E-01	4.36E-02	5.37E-02	6.52E-02	8.04E-02	8.63E-01	9.87E-02
Uranium (U)	1.63E-02	3.67E-02	9.40E-05	2.10E-04	3.89E-04	8.74E-04	3.62E-03	2.72E-04
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.23E-01	4.36E-02	5.47E-02	6.52E-02	8.19E-02	8.72E-01	9.97E-02
Uranium (U)	1.63E-02	3.90E-02	9.39E-05	2.24E-04	3.89E-04	9.30E-04	3.79E-03	2.84E-04
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.53E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.85E-02	4.02E-02	1.07E-04	2.30E-04	4.41E-04	9.58E-04	4.02E-03	3.02E-04
(4) Disruptive Event - Enhanced Erosion Case								
Aluminum (Al)	2.69E-02	2.69E-02	3.85E-03	3.85E-03	2.34E-03	2.34E-03	2.21E-02	7.28E-03
Copper (Cu)	2.74E-03	1.13E+02	3.76E-03	4.67E+01	2.29E-03	3.95E+01	2.53E+01	9.57E+01
Lead (Pb)	1.14E-03	1.45E+00	7.57E-05	1.10E-01	4.60E-05	1.64E-01	1.94E+00	2.22E-01
Uranium (U)	2.66E-05	3.18E-02	1.05E-06	1.83E-04	6.40E-07	7.58E-04	4.36E-03	3.27E-04
(5) Disruptive Event - Localized Cover Failure								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.32E-01	4.36E-02	5.54E-02	6.52E-02	8.29E-02	8.78E-01	1.00E-01
Uranium (U)	1.63E-02	3.99E-02	9.40E-05	2.28E-04	3.89E-04	9.49E-04	3.84E-03	2.89E-04
(6) Disruptive Event - Localized Liner Failure								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.12E-01	4.36E-02	5.39E-02	6.52E-02	8.06E-02	8.64E-01	9.88E-02
Uranium (U)	1.63E-02	3.72E-02	9.41E-05	2.14E-04	3.89E-04	8.87E-04	3.66E-03	2.75E-04

Non-Radiological COPCs	Purple Finch [2]		Meadow Vole [2]		Short-tailed Shrew [2]		Eastern Whip-poor-will [2]	White-tailed Deer [2]
	Garden Area	Grazing Area	Garden Area	Grazing Area	Garden Area	Grazing Area	Sitewide	Sitewide
(7) Disruptive Event - Damage to Berm								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.38E-01	4.36E-02	5.59E-02	6.52E-02	8.36E-02	8.82E-01	1.01E-01
Uranium (U)	1.63E-02	4.49E-02	9.39E-05	2.57E-04	3.89E-04	1.07E-03	4.19E-03	3.14E-04
(8) Dose Optimization - Wastes Grouted into Steel Liners								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.52E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	4.03E-02	9.39E-05	2.31E-04	3.89E-04	9.58E-04	3.87E-03	2.90E-04
(11) Defence-in-Depth - Role of Geosphere								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.31E-01	4.36E-02	5.53E-02	6.53E-02	8.28E-02	8.77E-01	1.00E-01
Uranium (U)	1.63E-02	4.02E-02	9.40E-05	2.30E-04	3.89E-04	9.58E-04	3.87E-03	2.90E-04
(12) Defence-in-Depth - Role of Cover								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.36E-01	4.36E-02	5.57E-02	6.52E-02	8.33E-02	8.81E-01	1.01E-01
Uranium (U)	1.63E-02	4.11E-02	9.40E-05	2.35E-04	3.89E-04	9.78E-04	3.92E-03	2.95E-04
(13) Defence-in-Depth - Role of Base Liner								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.73E-01	4.84E-01	4.84E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	5.76E-01	4.36E-02	4.36E-02	6.52E-02	6.52E-02	7.73E-01	8.84E-02
Uranium (U)	1.63E-02	1.63E-02	9.41E-05	9.41E-05	3.89E-04	3.89E-04	2.24E-03	1.68E-04
(14) Defence-in-Depth - Series of Landslides								
Aluminum (Al)	3.61E+01	3.61E+01	5.16E+00	5.16E+00	3.14E+00	3.14E+00	1.60E+01	5.27E+00
Copper (Cu)	1.41E-02	3.53E+02	1.94E-02	1.46E+02	1.18E-02	1.23E+02	7.91E+01	2.99E+02
Lead (Pb)	2.08E-03	1.69E+00	1.39E-04	1.28E-01	8.45E-05	1.92E-01	2.27E+00	2.60E-01
Uranium (U)	5.67E-05	6.06E-02	2.25E-06	3.48E-04	1.37E-06	1.44E-03	8.29E-03	6.22E-04
(15) What If - Human Intrusion, Mass Excavation and Farming								
Copper (Cu)	7.47E+01	6.97E+01	3.10E+01	2.89E+01	2.62E+01	2.44E+01	1.62E+01	6.13E+01
Lead (Pb)	1.23E+00	1.14E+00	9.30E-02	8.63E-02	1.39E-01	1.29E-01	1.59E+00	1.82E-01
Uranium (U)	5.19E-02	6.82E-02	2.97E-04	3.91E-04	1.23E-03	1.62E-03	8.20E-03	6.16E-04
(17) What If - Permanent Bathtub								
Copper (Cu)	1.38E+00	1.38E+00	5.73E-01	5.74E-01	4.84E-01	4.85E-01	3.10E-01	1.17E+00
Lead (Pb)	5.76E-01	7.37E-01	4.36E-02	5.58E-02	6.53E-02	8.35E-02	8.82E-01	1.01E-01
Uranium (U)	1.63E-02	4.11E-02	9.38E-05	2.35E-04	3.89E-04	9.77E-04	3.92E-03	2.94E-04

3.5 Dose Calculation Methods

The COPCs identified through the screening process (see Section 2.4) for inclusion in the EcoRA were quantitatively evaluated for all ecological receptors, based on the identified pathways and environmental media for each post-closure scenario. However, sufficient data were not available for the quantitative assessment of the monarch butterfly, common watersnake, eastern milksnake and snapping turtle (non-radiological) but inferences regarding their exposure are discussed in Section 5.2.

3.5.1 Radiological COPCs

For radiological COPCs, the resulting radiation dose involves both internal and external components, which are calculated separately. The total radiation dose, per radionuclide, is the sum of all internal and external doses. The overall radiation dose is the total sum of all internal/external doses from all radionuclides.

3.5.1.1 Aquatic biota – Internal & External Radiation Dose

For aquatic biota, the internal dose calculation is performed for each radionuclide, following Equation 3-5 (CSA 2012):

$$D_{\text{int}} = DC_{\text{int}} \times C_{tissue} \qquad (3\text{-}5)$$

where

D_{int} = internal radiation dose [μGy/hr]

DC_{int} = internal dose coefficient for radionuclide in tissue [μGy/hr per Bq/(kg fw)]

C_{tissue} = whole body tissue concentration [Bq/(kg fw)].

The external dose calculation is performed for each radionuclide, following Equation 3-6 (CSA 2012):

$$D_{ext} = DC_{ext}[(OF_w + 0.5 \times OF_{ws} + 0.5 \times OF_{ss}) \times C_w + (OF_s + 0.5 \times OF_{ss}) \times C_s] \qquad (3\text{-}6)$$

where

D_{ext} = external radiation dose [μGy/hr]

DC_{ext} = external dose coefficient for radionuclide in water or sediment [μGy/hr per Bq/kg; or μGy/hr per Bq/L]

OF_w = fraction of time spent immersed in surface water [unitless]

OF_s = fraction of time spent immersed in sediment [unitless]

OF_{ws} = fraction of time spent on the water's surface [unitless]

OF_{ss} = fraction of time spent on the sediment's surface [unitless]

C_w = surface water concentration [Bq/L]

C_s = sediment concentration [Bq/kg].

Parameter values are shown in Table 3-1.

3.5.1.2 Terrestrial Biota – Internal & External Radiation Dose

For terrestrial biota, the internal dose calculation is performed for each radionuclide, following Equation 3-7 (CSA 2012):

$$D_{\text{int}} = DC_{\text{int}} \times C_{tissue} \qquad (3\text{-}7)$$

where

D_{int} = internal radiation dose [μGy/hr]

DC_{int} = internal dose coefficient for radionuclide in tissue [μGy/hr per Bq/(kg fw)]

C_{tissue} = whole body tissue concentration [Bq/(kg fw)].

External dose calculation is performed for each radionuclide, following Equation 3-8 (CSA 2012):

$$D_{ext} = DC_{ext} \times OF_{soil} \times C_{soil} \qquad (3\text{-}8)$$

where

D_{ext} = external radiation dose [μGy/hr]

DC_{ext} = external dose coefficient for radionuclide in soil [μGy/hr per Bq/kg]

OF_{soil} = fraction of time spent immersed in soil [unitless]

C_{soil} = soil concentration [Bq/kg].

3.5.1.3 Dose Coefficients

The dose coefficients (DCs) used in the EcoRA calculations were obtained from the ERICA Assessment Tool (version 1.3, ERICA 2019). The DCs in ERICA are adapted from the FASSET Project (Pröhl *et al.* 2003). Weighting factors were added, as described below. Missing DC values were infilled from Amiro (1997). The DCs from Amiro (1997) are more conservative because they neglect organism geometry (i.e., assume infinite size) and therefore assume that all energies emitted by radionuclides from within the biota are absorbed by the biota, regardless of its actual size. The DCs from Amiro are also unweighted and an RBE factor of 10 was used for the alpha radiation component of internal dose from all alpha emitting radionuclides, following CSA (2012).

3.5.1.3.1 Radiological Weighting Factors

The radioecological weighting factor, also referred to as relative biological effectiveness (RBE), is the ratio of doses from different types of radiation needed to produce the same biological effect. For example,

$$\text{Alpha RBE} = \frac{\text{(Dose of gamma to produce a given effect)}}{\text{(Dose of alpha to produce the same effect)}}.$$

The radiological weighting factors recommended in the ERICA Tool (ERICA 2019) are:

- 10 for alpha radiation;
- 3 for low-energy (i.e., ≤ 10 eV) beta radiation; and
- 1 for high-energy (i.e., >10 eV) beta and gamma radiation.

These values are applied to internal and external dose calculations and are built into the DCs provided by ERICA, which are used in the present study.

There is uncertainty in the weighting factor value selected for alpha radiation. For example, FASSET (Pröhl *et al*. 2003) applies a weighting factor of 3 for both internal and external dose coefficients. CSA N288.1-14 (2018) recommends a value of 1-3 for Canadian nuclear facilities. The use of the ERICA-recommended weighting factor is conservative.

3.5.1.3.2 Mapping to Reference Organisms

Each of the ecological receptors identified for this EcoRA was mapped to a representative organism in ERICA, in order to select the most appropriate DC value. The following table shows the equivalent reference organism assigned to each EcoRA receptor and the occupancy factors.

The DCs used in this assessment are summarized in Table 3-9.

Table 3-8 Mapping of EcoRA Receptors to ERICA Representative Organisms and Assumed Occupancy Factors

EcoRA Receptor	Corresponding Representative Organism in ERICA	OFis	OFos	OFw
Aquatic Vegetation	Vascular Plant			1
Bald Eagle	Bird		1	
Belted Kingfisher	Bird			1
Benthic Fish	Benthic fish	0.5		0.5
Benthic Invertebrates	Benthic *	0.5		0.5
Black Bear	Mammal - Large		1	
Little Brown Myotis	Mammal - Small-Burrowing		1	
Canada Warbler	Bird		1	
Earthworm	Annelid	1		
Eastern Whip-poor-will	Bird		1	
Great Blue Heron	Bird			1
Green Frog	Amphibian		0.5	0.5
Mallard	Bird			1
Meadow Vole	Mammal - Small-Burrowing		1	
Moose	Mammal - Large		1	
Pelagic Fish	Pelagic fish			1
Purple Finch	Bird		1	
Ruffed Grouse	Bird		1	
Short-tailed Shrew	Mammal - Small-Burrowing	0.5	0.5	
Snapping Turtle	Reptile		0.5	0.5
Terrestrial Vegetation	Terrestrial Plants **		1	
White-tailed Deer	Mammal - Large		1	
Eastern Wolf	Mammal - Large		1	
Zooplankton	Zooplankton			1

Notes:
* maximum of several organisms: Mollusc – bivalve, Crustacean, Mollusc – gastropod and Insect larvae
** maximum of several organisms: Grasses & Herbs, Lichen & Bryophytes, Shrubs and Tree
OFis: occupancy factor in soil or sediment
OFos: occupancy factor on soil or sediment surface
OFw: occupancy factor in water

Table 3-9 Dose Coefficients used in the EcoRA

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Black Bear					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	8.06E-09	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	1.31E-10	-	-
Co-60	ERICA (2019)	7.45E-06	2.28E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	2.98E-06	4.91E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	5.26E-07	3.51E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	5.61E-06	1.40E-06	-	-
Ni-59	ERICA (2019)	8.06E-08	3.24E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	1.23E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	2.95E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	6.75E-10	-	-
Po-210	ERICA (2019)	2.72E-04	7.54E-12	-	-
Pu-239	ERICA (2019)	2.63E-04	8.33E-11	-	-
Pu-241	ERICA (2019)	7.07E-08	8.77E-13	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.22E-03	1.58E-06	-	-
Ra-228	ERICA (2019)	5.45E-06	8.50E-07	-	-
Sr-90	ERICA (2019)	5.70E-06	4.03E-14	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.66E-03	1.40E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	2.19E-10	-	-
Th-232	ERICA (2019)	2.02E-04	1.14E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	1.49E-10	-	-
U-235	ERICA (2019)	2.22E-04	1.14E-07	-	-
U-238	ERICA (2019)	2.10E-04	8.77E-11	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Little Brown Myotis					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.63E-10	-	-
Co-60	ERICA (2019)	1.49E-06	4.21E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Cs-137	ERICA (2019)	1.49E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.57E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	1.58E-06	2.72E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.07E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	6.26E-08	-	-
Pb-210	ERICA (2019)	2.19E-06	2.45E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.18E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.07E-06	1.67E-06	-	-
Sr-90	ERICA (2019)	5.43E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.05E-10	-	-
Th-232	ERICA (2019)	2.02E-04	3.68E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	5.87E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.12E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Bald Eagle					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.72E-10	-	-
Co-60	ERICA (2019)	2.10E-06	4.30E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	1.67E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.71E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	1.93E-06	2.81E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.16E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	5.87E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	2.45E-09	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.26E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.35E-06	1.67E-06	-	-
Sr-90	ERICA (2019)	5.52E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.14E-10	-	-
Th-232	ERICA (2019)	2.02E-04	3.77E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	6.05E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.21E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Canada Warbler					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.72E-10	-	-
Co-60	ERICA (2019)	2.10E-06	4.30E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	1.67E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.71E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	1.93E-06	2.81E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.16E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	5.87E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	2.45E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.26E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.35E-06	1.67E-06	-	-
Sr-90	ERICA (2019)	5.52E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.14E-10	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Th-232	ERICA (2019)	2.02E-04	3.77E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	6.05E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.21E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
White-tailed Deer					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	8.06E-09	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	1.31E-10	-	-
Co-60	ERICA (2019)	7.45E-06	2.28E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	2.98E-06	4.91E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	5.26E-07	3.51E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	5.61E-06	1.40E-06	-	-
Ni-59	ERICA (2019)	8.06E-08	3.24E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	1.23E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	2.95E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	6.75E-10	-	-
Po-210	ERICA (2019)	2.72E-04	7.54E-12	-	-
Pu-239	ERICA (2019)	2.63E-04	8.33E-11	-	-
Pu-241	ERICA (2019)	7.07E-08	8.77E-13	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	Terr Summary	1.22E-03	1.58E-06	-	-
Ra-228	ERICA (2019)	5.45E-06	8.50E-07	-	-
Sr-90	ERICA (2019)	5.70E-06	4.03E-14	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.66E-03	1.40E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	Terr Summary	2.37E-04	2.19E-10	-	-
Th-232	Terr Summary	2.02E-04	1.14E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	1.49E-10	-	-
U-235	ERICA (2019)	2.22E-04	1.14E-07	-	-
U-238	ERICA (2019)	2.10E-04	8.77E-11	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Earthworm					
Ac-227	Amiro (1997)	4.61E-06 *	-	2.14E-08	-
Ag-108m	ERICA (2019)	N/A	-	N/A	-
Am-241	ERICA (2019)	2.78E-04	-	5.35E-08	-
Am-243	ERICA (2019)	N/A	-	N/A	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
C-14	ERICA (2019)	2.50E-07	-	0.00E+00	-
Cl-36	ERICA (2019)	1.31E-06	-	7.01E-10	-
Co-60	ERICA (2019)	6.75E-07	-	1.14E-05	-
Cs-135	ERICA (2019)	3.49E-07	-	0.00E+00	-
Cs-137	ERICA (2019)	1.23E-06	-	2.63E-06	-
Cu-29	ERICA (2019)	N/A	-	N/A	-
I-129	ERICA (2019)	4.20E-07	-	3.07E-08	-
Mo-93	Amiro (1997)	8.22E-08	-	7.46E-08	-
Nb-93m	Amiro (1997)	1.53E-07	-	1.34E-08	-
Nb-94	ERICA (2019)	9.64E-07	-	7.36E-06	-
Ni-59	ERICA (2019)	7.93E-08	-	8.77E-10	-
Ni-63	ERICA (2019)	1.08E-07	-	0.00E+00	-
Np-237	ERICA (2019)	2.41E-04	-	6.66E-08	-
Pa-231	ERICA (2019)	2.52E-04	-	1.56E-07	-
Pb-210	ERICA (2019)	2.10E-06	-	5.26E-09	-
Po-210	ERICA (2019)	2.72E-04	-	3.94E-11	-
Pu-239	ERICA (2019)	2.63E-04	-	7.45E-10	-
Pu-241	ERICA (2019)	7.07E-08	-	4.91E-12	-
Pu-242	Amiro (1997)	2.52E-04 *	-	1.01E-08	-
Ra-226	ERICA (2019)	1.20E-03	-	7.89E-06	-
Ra-228	ERICA (2019)	2.51E-06	-	4.38E-06	-
Sr-90	ERICA (2019)	4.56E-06	-	1.31E-12	-
Tc-99	ERICA (2019)	5.08E-07	-	0.00E+00	-
Th-228	ERICA (2019)	1.62E-03	-	6.92E-06	-
Th-229	Amiro (1997)	2.61E-04 *	-	6.52E-07	-
Th-230	ERICA (2019)	2.37E-04	-	1.84E-09	-
Th-232	ERICA (2019)	2.02E-04	-	1.23E-09	-
U-233	Amiro (1997)	2.48E-04 *	-	9.42E-09	-
U-234	ERICA (2019)	2.45E-04	-	1.49E-09	-
U-235	ERICA (2019)	2.26E-04	-	5.87E-07	-
U-238	ERICA (2019)	2.10E-04	-	1.05E-09	-
Zr-93	Amiro (1997)	9.92E-08	-	0.00E+00	-
Aquatic Vegetation					
Ac-227	Amiro (1997)	4.61E-06 *	-	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	-	N/A
Am-241	ERICA (2019)	2.78E-04	-	-	1.58E-07
Am-243	ERICA (2019)	N/A	-	-	N/A
C-14	ERICA (2019)	2.41E-07	-	-	9.64E-09
Cl-36	ERICA (2019)	9.64E-07	-	-	4.82E-07
Co-60	ERICA (2019)	4.56E-07	-	-	1.23E-05
Cs-135	ERICA (2019)	3.22E-07	-	-	2.37E-08
Cs-137	ERICA (2019)	8.59E-07	-	-	3.24E-06
Cu-29	ERICA (2019)	N/A	-	-	N/A
I-129	ERICA (2019)	4.04E-07	-	-	1.31E-07
Mo-93	Amiro (1997)	8.22E-08	-	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	-	8.90E-12
Nb-94	ERICA (2019)	6.66E-07	-	-	8.15E-06
Ni-59	ERICA (2019)	7.63E-08	-	-	5.70E-09

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Ni-63	ERICA (2019)	1.07E-07	-	-	5.45E-10
Np-237	ERICA (2019)	2.43E-04	-	-	1.75E-07
Pa-231	ERICA (2019)	2.52E-04	-	-	2.42E-07
Pb-210	ERICA (2019)	1.39E-06	-	-	8.42E-07
Po-210	ERICA (2019)	2.72E-04	-	-	4.30E-11
Pu-239	ERICA (2019)	2.63E-04	-	-	3.51E-09
Pu-241	ERICA (2019)	7.07E-08	-	-	4.15E-11
Pu-242	Amiro (1997)	2.52E-04 *	-	-	6.70E-12
Ra-226	ERICA (2019)	1.21E-03	-	-	1.14E-05
Ra-228	ERICA (2019)	1.74E-06	-	-	5.79E-06
Sr-90	ERICA (2019)	2.45E-06	-	-	3.24E-06
Tc-99	ERICA (2019)	4.47E-07	-	-	6.75E-08
Th-228	ERICA (2019)	1.64E-03	-	-	1.05E-05
Th-229	Amiro (1997)	2.61E-04 *	-	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	-	8.24E-09
Th-232	ERICA (2019)	2.02E-04	-	-	6.66E-09
U-233	Amiro (1997)	2.48E-04 *	-	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	-	8.33E-09
U-235	ERICA (2019)	2.28E-04	-	-	9.64E-07
U-238	ERICA (2019)	2.10E-04	-	-	6.31E-09
Zr-93	Amiro (1997)	9.92E-08	-	-	0.00E+00
Benthic Fish					
Ac-227	Amiro (1997)	4.61E-06 *	-	2.14E-08	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	N/A	N/A
Am-241	ERICA (2019)	2.78E-04	-	5.43E-08	9.64E-08
Am-243	ERICA (2019)	N/A	-	N/A	N/A
C-14	ERICA (2019)	2.59E-07	-	0.00E+00	1.49E-10
Cl-36	ERICA (2019)	1.40E-06	-	7.10E-10	1.14E-08
Co-60	ERICA (2019)	2.02E-06	-	1.14E-05	1.14E-05
Cs-135	ERICA (2019)	3.49E-07	-	0.00E+00	3.59E-10
Cs-137	ERICA (2019)	1.67E-06	-	2.72E-06	2.45E-06
Cu-29	ERICA (2019)	N/A	-	N/A	N/A
I-129	ERICA (2019)	4.71E-07	-	3.16E-08	6.40E-08
Mo-93	Amiro (1997)	8.22E-08	-	7.46E-08	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	1.34E-08	8.90E-12
Nb-94	ERICA (2019)	1.93E-06	-	7.45E-06	6.92E-06
Ni-59	ERICA (2019)	8.13E-08	-	8.77E-10	2.02E-10
Ni-63	ERICA (2019)	1.08E-07	-	0.00E+00	9.64E-12
Np-237	ERICA (2019)	2.41E-04	-	6.75E-08	1.05E-07
Pa-231	ERICA (2019)	2.52E-04	-	1.57E-07	1.63E-07
Pb-210	ERICA (2019)	2.28E-06	-	5.35E-09	3.33E-08
Po-210	ERICA (2019)	2.72E-04	-	4.03E-11	3.77E-11
Pu-239	ERICA (2019)	2.63E-04	-	7.54E-10	6.84E-10
Pu-241	ERICA (2019)	7.07E-08	-	4.91E-12	7.19E-12
Pu-242	Amiro (1997)	2.52E-04 *	-	1.01E-08	6.70E-12
Ra-226	ERICA (2019)	1.26E-03	-	7.98E-06	7.98E-06
Ra-228	ERICA (2019)	3.25E-06	-	4.38E-06	4.30E-06
Sr-90	ERICA (2019)	5.52E-06	-	1.40E-12	1.84E-07

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Tc-99	ERICA (2019)	5.08E-07	-	0.00E+00	9.64E-10
Th-228	ERICA (2019)	1.61E-03	-	6.92E-06	7.19E-06
Th-229	Amiro (1997)	2.61E-04 *	-	6.52E-07	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	1.84E-09	2.10E-09
Th-232	ERICA (2019)	2.02E-04	-	1.31E-09	1.23E-09
U-233	Amiro (1997)	2.48E-04 *	-	9.42E-09	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	1.58E-09	1.31E-09
U-235	ERICA (2019)	2.26E-04	-	5.87E-07	7.19E-07
U-238	ERICA (2019)	2.10E-04	-	1.14E-09	8.33E-10
Zr-93	Amiro (1997)	9.92E-08	-	0.00E+00	0.00E+00
Benthic Invertebrates					
Ac-227	Amiro (1997)	4.61E-06 *	-	2.14E-08	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	N/A	N/A
Am-241	ERICA (2019)	2.78E-04	-	5.43E-08	1.58E-07
Am-243	ERICA (2019)	N/A	-	N/A	N/A
C-14	ERICA (2019)	2.50E-07	-	0.00E+00	7.89E-09
Cl-36	ERICA (2019)	1.40E-06	-	7.10E-10	4.73E-07
Co-60	ERICA (2019)	1.05E-06	-	1.14E-05	1.23E-05
Cs-135	ERICA (2019)	3.49E-07	-	0.00E+00	1.93E-08
Cs-137	ERICA (2019)	1.40E-06	-	2.72E-06	3.24E-06
Cu-29	ERICA (2019)	N/A	-	N/A	N/A
I-129	ERICA (2019)	4.35E-07	-	3.16E-08	1.31E-07
Mo-93	Amiro (1997)	8.22E-08	-	7.46E-08	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	1.34E-08	8.90E-12
Nb-94	ERICA (2019)	1.23E-06	-	7.45E-06	8.15E-06
Ni-59	ERICA (2019)	7.93E-08	-	8.77E-10	6.14E-09
Ni-63	ERICA (2019)	1.08E-07	-	0.00E+00	5.00E-10
Np-237	ERICA (2019)	2.43E-04	-	6.75E-08	1.75E-07
Pa-231	ERICA (2019)	2.52E-04	-	1.57E-07	2.42E-07
Pb-210	ERICA (2019)	2.19E-06	-	5.35E-09	9.64E-07
Po-210	ERICA (2019)	2.72E-04	-	4.03E-11	4.30E-11
Pu-239	ERICA (2019)	2.63E-04	-	7.54E-10	3.51E-09
Pu-241	ERICA (2019)	7.07E-08	-	4.91E-12	1.31E-11
Pu-242	Amiro (1997)	2.52E-04 *	-	1.01E-08	6.70E-12
Ra-226	ERICA (2019)	1.21E-03	-	7.98E-06	1.14E-05
Ra-228	ERICA (2019)	2.88E-06	-	4.38E-06	6.05E-06
Sr-90	ERICA (2019)	5.26E-06	-	1.40E-12	3.94E-06
Tc-99	ERICA (2019)	5.08E-07	-	0.00E+00	5.00E-08
Th-228	ERICA (2019)	1.65E-03	-	6.92E-06	1.14E-05
Th-229	Amiro (1997)	2.61E-04 *	-	6.52E-07	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	1.84E-09	8.06E-09
Th-232	ERICA (2019)	2.02E-04	-	1.31E-09	6.57E-09
U-233	Amiro (1997)	2.48E-04 *	-	9.42E-09	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	1.58E-09	8.33E-09
U-235	ERICA (2019)	2.28E-04	-	5.87E-07	9.64E-07
U-238	ERICA (2019)	2.10E-04	-	1.14E-09	6.40E-09
Zr-93	Amiro (1997)	9.92E-08	-	0.00E+00	0.00E+00

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Pelagic Fish					
Ac-227	Amiro (1997)	4.61E-06 *	-	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	-	N/A
Am-241	ERICA (2019)	2.78E-04	-	-	9.64E-08
Am-243	ERICA (2019)	N/A	-	-	N/A
C-14	ERICA (2019)	2.59E-07	-	-	1.58E-10
Cl-36	ERICA (2019)	1.40E-06	-	-	1.23E-08
Co-60	ERICA (2019)	1.84E-06	-	-	1.14E-05
Cs-135	ERICA (2019)	3.49E-07	-	-	3.77E-10
Cs-137	ERICA (2019)	1.58E-06	-	-	2.54E-06
Cu-29	ERICA (2019)	N/A	-	-	N/A
I-129	ERICA (2019)	4.60E-07	-	-	6.75E-08
Mo-93	Amiro (1997)	8.22E-08	-	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	-	8.90E-12
Nb-94	ERICA (2019)	1.84E-06	-	-	7.01E-06
Ni-59	ERICA (2019)	8.13E-08	-	-	2.19E-10
Ni-63	ERICA (2019)	1.08E-07	-	-	9.64E-12
Np-237	ERICA (2019)	2.41E-04	-	-	1.05E-07
Pa-231	ERICA (2019)	2.52E-04	-	-	1.65E-07
Pb-210	ERICA (2019)	2.28E-06	-	-	3.51E-08
Po-210	ERICA (2019)	2.72E-04	-	-	3.77E-11
Pu-239	ERICA (2019)	2.63E-04	-	-	7.19E-10
Pu-241	ERICA (2019)	7.07E-08	-	-	7.36E-12
Pu-242	Amiro (1997)	2.52E-04 *	-	-	6.70E-12
Ra-226	ERICA (2019)	1.26E-03	-	-	8.06E-06
Ra-228	ERICA (2019)	3.25E-06	-	-	4.38E-06
Sr-90	ERICA (2019)	5.52E-06	-	-	2.10E-07
Tc-99	ERICA (2019)	5.08E-07	-	-	1.05E-09
Th-228	ERICA (2019)	1.61E-03	-	-	7.28E-06
Th-229	Amiro (1997)	2.61E-04 *	-	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	-	2.19E-09
Th-232	ERICA (2019)	2.02E-04	-	-	1.31E-09
U-233	Amiro (1997)	2.48E-04 *	-	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	-	1.40E-09
U-235	ERICA (2019)	2.26E-04	-	-	7.28E-07
U-238	ERICA (2019)	2.10E-04	-	-	8.77E-10
Zr-93	Amiro (1997)	9.92E-08	-	-	0.00E+00
Great Blue Heron					
Ac-227	Amiro (1997)	4.61E-06 *	-	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	-	N/A
Am-241	ERICA (2019)	2.78E-04	-	-	9.64E-08
Am-243	ERICA (2019)	N/A	-	-	N/A
C-14	ERICA (2019)	2.59E-07	-	-	1.58E-10
Cl-36	ERICA (2019)	1.40E-06	-	-	1.23E-08
Co-60	ERICA (2019)	2.10E-06	-	-	1.14E-05
Cs-135	ERICA (2019)	3.49E-07	-	-	3.77E-10
Cs-137	ERICA (2019)	1.67E-06	-	-	2.45E-06
Cu-29	ERICA (2019)	N/A	-	-	N/A

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
I-129	ERICA (2019)	4.71E-07	-	-	6.22E-08
Mo-93	Amiro (1997)	8.22E-08	-	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	-	8.90E-12
Nb-94	ERICA (2019)	1.93E-06	-	-	6.84E-06
Ni-59	ERICA (2019)	8.13E-08	-	-	2.19E-10
Ni-63	ERICA (2019)	1.08E-07	-	-	9.64E-12
Np-237	ERICA (2019)	2.41E-04	-	-	1.05E-07
Pa-231	ERICA (2019)	2.52E-04	-	-	1.61E-07
Pb-210	ERICA (2019)	2.28E-06	-	-	3.42E-08
Po-210	ERICA (2019)	2.72E-04	-	-	3.68E-11
Pu-239	ERICA (2019)	2.63E-04	-	-	6.75E-10
Pu-241	ERICA (2019)	7.07E-08	-	-	7.19E-12
Pu-242	Amiro (1997)	2.52E-04 *	-	-	6.70E-12
Ra-226	ERICA (2019)	1.26E-03	-	-	7.89E-06
Ra-228	ERICA (2019)	3.35E-06	-	-	4.30E-06
Sr-90	ERICA (2019)	5.52E-06	-	-	1.75E-07
Tc-99	ERICA (2019)	5.08E-07	-	-	1.05E-09
Th-228	ERICA (2019)	1.61E-03	-	-	7.10E-06
Th-229	Amiro (1997)	2.61E-04 *	-	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	-	2.10E-09
Th-232	ERICA (2019)	2.02E-04	-	-	1.23E-09
U-233	Amiro - RBE 10	2.48E-04	-	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	-	1.31E-09
U-235	ERICA (2019)	2.26E-04	-	-	7.10E-07
U-238	ERICA (2019)	2.10E-04	-	-	8.33E-10
Zr-93	Amiro (1997)	9.92E-08	-	-	0.00E+00
Green Frog					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	N/A	-	N/A
Am-241	ERICA (2019)	2.78E-04	2.28E-08	-	1.23E-07
Am-243	ERICA (2019)	N/A	N/A	-	N/A
C-14	ERICA (2019)	2.50E-07	0.00E+00	-	5.17E-10
Cl-36	ERICA (2019)	1.40E-06	2.72E-10	-	3.68E-08
Co-60	ERICA (2019)	9.64E-07	4.30E-06	-	1.23E-05
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	1.23E-09
Cs-137	ERICA (2019)	1.31E-06	9.64E-07	-	2.81E-06
Cu-29	ERICA (2019)	N/A	N/A	-	N/A
I-129	ERICA (2019)	4.31E-07	9.64E-09	-	1.05E-07
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	8.90E-12
Nb-94	ERICA (2019)	1.14E-06	2.81E-06	-	7.63E-06
Ni-59	ERICA (2019)	8.00E-08	8.77E-42	-	7.36E-10
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	3.33E-11
Np-237	ERICA (2019)	2.41E-04	3.16E-08	-	1.40E-07
Pa-231	ERICA (2019)	2.52E-04	6.43E-08	-	1.96E-07
Pb-210	ERICA (2019)	2.19E-06	2.45E-09	-	9.64E-08
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	4.12E-11
Pu-239	ERICA (2019)	2.63E-04	2.89E-10	-	1.58E-09

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	9.64E-12
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	6.70E-12
Ra-226	ERICA (2019)	1.18E-03	2.98E-06	-	8.77E-06
Ra-228	ERICA (2019)	2.79E-06	1.67E-06	-	4.82E-06
Sr-90	ERICA (2019)	5.17E-06	1.40E-13	-	5.52E-07
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	3.24E-09
Th-228	ERICA (2019)	1.62E-03	2.54E-06	-	8.06E-06
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	6.22E-10	-	3.59E-09
Th-232	ERICA (2019)	2.02E-04	3.77E-10	-	2.54E-09
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	6.05E-10	-	3.24E-09
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	8.33E-07
U-238	ERICA (2019)	2.10E-04	4.21E-10	-	2.37E-09
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	0.00E+00
Eastern Whip-poor-will					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.72E-10	-	-
Co-60	ERICA (2019)	2.10E-06	4.30E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	1.67E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.71E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	1.93E-06	2.81E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.16E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	5.87E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	2.45E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.26E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.35E-06	1.67E-06	-	-
Sr-90	ERICA (2019)	5.52E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.14E-10	-	-
Th-232	ERICA (2019)	2.02E-04	3.77E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
U-234	ERICA (2019)	2.45E-04	6.05E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.21E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Mallard					
Ac-227	Amiro (1997)	4.61E-06 *	-	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	-	N/A
Am-241	ERICA (2019)	2.78E-04	-	-	9.64E-08
Am-243	ERICA (2019)	N/A	-	-	N/A
C-14	ERICA (2019)	2.59E-07	-	-	1.58E-10
Cl-36	ERICA (2019)	1.40E-06	-	-	1.23E-08
Co-60	ERICA (2019)	2.10E-06	-	-	1.14E-05
Cs-135	ERICA (2019)	3.49E-07	-	-	3.77E-10
Cs-137	ERICA (2019)	1.67E-06	-	-	2.45E-06
Cu-29	ERICA (2019)	N/A	-	-	N/A
I-129	ERICA (2019)	4.71E-07	-	-	6.22E-08
Mo-93	Amiro (1997)	8.22E-08	-	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	-	8.90E-12
Nb-94	ERICA (2019)	1.93E-06	-	-	6.84E-06
Ni-59	ERICA (2019)	8.13E-08	-	-	2.19E-10
Ni-63	ERICA (2019)	1.08E-07	-	-	9.64E-12
Np-237	ERICA (2019)	2.41E-04	-	-	1.05E-07
Pa-231	ERICA (2019)	2.52E-04	-	-	1.61E-07
Pb-210	ERICA (2019)	2.28E-06	-	-	3.42E-08
Po-210	ERICA (2019)	2.72E-04	-	-	3.68E-11
Pu-239	ERICA (2019)	2.63E-04	-	-	6.75E-10
Pu-241	ERICA (2019)	7.07E-08	-	-	7.19E-12
Pu-242	Amiro (1997)	2.52E-04 *	-	-	6.70E-12
Ra-226	ERICA (2019)	1.26E-03	-	-	7.89E-06
Ra-228	ERICA (2019)	3.35E-06	-	-	4.30E-06
Sr-90	ERICA (2019)	5.52E-06	-	-	1.75E-07
Tc-99	ERICA (2019)	5.08E-07	-	-	1.05E-09
Th-228	ERICA (2019)	1.61E-03	-	-	7.10E-06
Th-229	Amiro (1997)	2.61E-04 *	-	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	-	2.10E-09
Th-232	ERICA (2019)	2.02E-04	-	-	1.23E-09
U-233	Amiro (1997)	2.48E-04 *	-	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	-	1.31E-09
U-235	ERICA (2019)	2.26E-04	-	-	7.10E-07
U-238	ERICA (2019)	2.10E-04	-	-	8.33E-10
Zr-93	Amiro (1997)	9.92E-08	-	-	0.00E+00
Zooplankton					
Ac-227	Amiro (1997)	4.61E-06 *	-	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	-	N/A
Am-241	ERICA (2019)	2.78E-04	-	-	1.67E-07
Am-243	ERICA (2019)	N/A	-	-	N/A
C-14	ERICA (2019)	2.41E-07	-	-	1.14E-08
Cl-36	ERICA (2019)	7.01E-07	-	-	7.10E-07

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Co-60	ERICA (2019)	4.21E-07	-	-	1.31E-05
Cs-135	ERICA (2019)	3.22E-07	-	-	2.63E-08
Cs-137	ERICA (2019)	6.66E-07	-	-	3.42E-06
Cu-29	ERICA (2019)	N/A	-	-	N/A
I-129	ERICA (2019)	4.04E-07	-	-	1.31E-07
Mo-93	Amiro (1997)	8.22E-08	-	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	-	8.90E-12
Nb-94	ERICA (2019)	5.96E-07	-	-	8.24E-06
Ni-59	ERICA (2019)	7.58E-08	-	-	6.66E-09
Ni-63	ERICA (2019)	1.07E-07	-	-	7.63E-10
Np-237	ERICA (2019)	2.43E-04	-	-	1.75E-07
Pa-231	ERICA (2019)	2.52E-04	-	-	2.47E-07
Pb-210	ERICA (2019)	9.47E-07	-	-	1.31E-06
Po-210	ERICA (2019)	2.72E-04	-	-	4.30E-11
Pu-239	ERICA (2019)	2.63E-04	-	-	3.68E-09
Pu-241	ERICA (2019)	7.07E-08	-	-	1.58E-11
Pu-242	Amiro (1997)	2.52E-04 *	-	-	6.70E-12
Ra-226	ERICA (2019)	1.21E-03	-	-	1.23E-05
Ra-228	ERICA (2019)	1.20E-06	-	-	6.31E-06
Sr-90	ERICA (2019)	1.23E-06	-	-	4.47E-06
Tc-99	ERICA (2019)	4.38E-07	-	-	7.36E-08
Th-228	ERICA (2019)	1.65E-03	-	-	1.23E-05
Th-229	Amiro (1997)	2.61E-04 *	-	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	-	8.77E-09
Th-232	ERICA (2019)	2.02E-04	-	-	7.28E-09
U-233	Amiro (1997)	2.48E-04 *	-	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	-	8.77E-09
U-235	ERICA (2019)	2.28E-04	-	-	9.64E-07
U-238	ERICA (2019)	2.10E-04	-	-	6.84E-09
Zr-93	Amiro (1997)	9.92E-08	-	-	0.00E+00
Snapping Turtle					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	N/A	-	N/A
Am-241	ERICA (2019)	2.77E-04	2.10E-08	-	9.52E-08
Am-243	ERICA (2019)	N/A	N/A	-	N/A
C-14	ERICA (2019)	2.56E-07	0.00E+00	-	1.72E-10
Cl-36	ERICA (2019)	1.37E-06	2.63E-10	-	1.26E-08
Co-60	ERICA (2019)	1.99E-06	4.12E-06	-	1.12E-05
Cs-135	ERICA (2019)	3.46E-07	0.00E+00	-	4.02E-10
Cs-137	ERICA (2019)	1.64E-06	9.64E-07	-	2.47E-06
Cu-29	ERICA (2019)	N/A	N/A	-	N/A
I-129	ERICA (2019)	4.69E-07	9.64E-09	-	6.47E-08
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	8.90E-12
Nb-94	ERICA (2019)	1.89E-06	2.63E-06	-	6.92E-06
Ni-59	ERICA (2019)	8.10E-08	8.77E-42	-	2.33E-10
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	1.27E-11
Np-237	ERICA (2019)	2.42E-04	2.98E-08	-	1.07E-07

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Pa-231	ERICA (2019)	2.52E-04	6.08E-08	-	1.64E-07
Pb-210	ERICA (2019)	2.22E-06	6.31E-08	-	3.63E-08
Po-210	ERICA (2019)	2.68E-04	1.40E-11	-	3.74E-11
Pu-239	ERICA (2019)	2.60E-04	2.72E-10	-	7.14E-10
Pu-241	ERICA (2019)	7.10E-08	2.19E-12	-	7.31E-12
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	6.70E-12
Ra-226	ERICA (2019)	1.22E-03	2.89E-06	-	7.96E-06
Ra-228	ERICA (2019)	3.26E-06	1.58E-06	-	4.30E-06
Sr-90	ERICA (2019)	5.53E-06	1.31E-13	-	1.86E-07
Tc-99	ERICA (2019)	5.14E-07	0.00E+00	-	1.13E-09
Th-228	ERICA (2019)	1.63E-03	2.45E-06	-	7.16E-06
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	4.34E-10
Th-230	ERICA (2019)	2.36E-04	5.87E-10	-	2.18E-09
Th-232	ERICA (2019)	2.02E-04	3.59E-10	-	1.31E-09
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	6.28E-12
U-234	ERICA (2019)	2.41E-04	5.79E-10	-	1.43E-09
U-235	ERICA (2019)	2.24E-04	2.45E-07	-	7.20E-07
U-238	ERICA (2019)	2.12E-04	4.03E-10	-	8.92E-10
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	0.00E+00
Belted Kingfisher					
Ac-227	Amiro (1997)	4.61E-06 *	-	-	1.42E-11
Ag-108m	ERICA (2019)	N/A	-	-	N/A
Am-241	ERICA (2019)	2.78E-04	-	-	9.64E-08
Am-243	ERICA (2019)	N/A	-	-	N/A
C-14	ERICA (2019)	2.59E-07	-	-	1.58E-10
Cl-36	ERICA (2019)	1.40E-06	-	-	1.23E-08
Co-60	ERICA (2019)	2.10E-06	-	-	1.14E-05
Cs-135	ERICA (2019)	3.49E-07	-	-	3.77E-10
Cs-137	ERICA (2019)	1.67E-06	-	-	2.45E-06
Cu-29	ERICA (2019)	N/A	-	-	N/A
I-129	ERICA (2019)	4.71E-07	-	-	6.22E-08
Mo-93	Amiro (1997)	8.22E-08	-	-	4.97E-11
Nb-93m	Amiro (1997)	1.53E-07	-	-	8.90E-12
Nb-94	ERICA (2019)	1.93E-06	-	-	6.84E-06
Ni-59	ERICA (2019)	8.13E-08	-	-	2.19E-10
Ni-63	ERICA (2019)	1.08E-07	-	-	9.64E-12
Np-237	ERICA (2019)	2.41E-04	-	-	1.05E-07
Pa-231	ERICA (2019)	2.52E-04	-	-	1.61E-07
Pb-210	ERICA (2019)	2.28E-06	-	-	3.42E-08
Po-210	ERICA (2019)	2.72E-04	-	-	3.68E-11
Pu-239	ERICA (2019)	2.63E-04	-	-	6.75E-10
Pu-241	ERICA (2019)	7.07E-08	-	-	7.19E-12
Pu-242	Amiro (1997)	2.52E-04 *	-	-	6.70E-12
Ra-226	ERICA (2019)	1.26E-03	-	-	7.89E-06
Ra-228	ERICA (2019)	3.35E-06	-	-	4.30E-06
Sr-90	ERICA (2019)	5.52E-06	-	-	1.75E-07
Tc-99	ERICA (2019)	5.08E-07	-	-	1.05E-09
Th-228	ERICA (2019)	1.61E-03	-	-	7.10E-06

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Th-229	Amiro (1997)	2.61E-04 *	-	-	4.34E-10
Th-230	ERICA (2019)	2.37E-04	-	-	2.10E-09
Th-232	ERICA (2019)	2.02E-04	-	-	1.23E-09
U-233	Amiro (1997)	2.48E-04 *	-	-	6.28E-12
U-234	ERICA (2019)	2.45E-04	-	-	1.31E-09
U-235	ERICA (2019)	2.26E-04	-	-	7.10E-07
U-238	ERICA (2019)	2.10E-04	-	-	8.33E-10
Zr-93	Amiro (1997)	9.92E-08	-	-	0.00E+00
Purple Finch					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.72E-10	-	-
Co-60	ERICA (2019)	2.10E-06	4.30E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	1.67E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.71E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	1.93E-06	2.81E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.16E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	5.87E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	2.45E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.26E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.35E-06	1.67E-06	-	-
Sr-90	ERICA (2019)	5.52E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.14E-10	-	-
Th-232	ERICA (2019)	2.02E-04	3.77E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	6.05E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.21E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Moose					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Am-241	ERICA (2019)	2.78E-04	8.06E-09	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	1.31E-10	-	-
Co-60	ERICA (2019)	7.45E-06	2.28E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	2.98E-06	4.91E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	5.26E-07	3.51E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	5.61E-06	1.40E-06	-	-
Ni-59	ERICA (2019)	8.06E-08	3.24E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	1.23E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	2.95E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	6.75E-10	-	-
Po-210	ERICA (2019)	2.72E-04	7.54E-12	-	-
Pu-239	ERICA (2019)	2.63E-04	8.33E-11	-	-
Pu-241	ERICA (2019)	7.07E-08	8.77E-13	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.22E-03	1.58E-06	-	-
Ra-228	ERICA (2019)	5.45E-06	8.50E-07	-	-
Sr-90	ERICA (2019)	5.70E-06	4.03E-14	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.66E-03	1.40E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	2.19E-10	-	-
Th-232	ERICA (2019)	2.02E-04	1.14E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	1.49E-10	-	-
U-235	ERICA (2019)	2.22E-04	1.14E-07	-	-
U-238	ERICA (2019)	2.10E-04	8.77E-11	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Ruffed Grouse					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.72E-10	-	-
Co-60	ERICA (2019)	2.10E-06	4.30E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	1.67E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.71E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Nb-94	ERICA (2019)	1.93E-06	2.81E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.16E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	5.87E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	2.45E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.26E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.35E-06	1.67E-06	-	-
Sr-90	ERICA (2019)	5.52E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.14E-10	-	-
Th-232	ERICA (2019)	2.02E-04	3.77E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	6.05E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.21E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Eastern Wolf					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	8.06E-09	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	1.31E-10	-	-
Co-60	ERICA (2019)	7.45E-06	2.28E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	2.98E-06	4.91E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	5.26E-07	3.51E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	5.61E-06	1.40E-06	-	-
Ni-59	ERICA (2019)	8.06E-08	3.24E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	1.23E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	2.95E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	6.75E-10	-	-
Po-210	ERICA (2019)	2.72E-04	7.54E-12	-	-
Pu-239	ERICA (2019)	2.63E-04	8.33E-11	-	-
Pu-241	ERICA (2019)	7.07E-08	8.77E-13	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.22E-03	1.58E-06	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Ra-228	ERICA (2019)	5.45E-06	8.50E-07	-	-
Sr-90	ERICA (2019)	5.70E-06	4.03E-14	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.66E-03	1.40E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	2.19E-10	-	-
Th-232	ERICA (2019)	2.02E-04	1.14E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	1.49E-10	-	-
U-235	ERICA (2019)	2.22E-04	1.14E-07	-	-
U-238	ERICA (2019)	2.10E-04	8.77E-11	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Short-tailed Shrew					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	2.14E-08	-
Ag-108m	ERICA (2019)	N/A	N/A	N/A	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	4.82E-08	-
Am-243	ERICA (2019)	N/A	N/A	N/A	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	0.00E+00	-
Cl-36	ERICA (2019)	1.40E-06	2.63E-10	6.57E-10	-
Co-60	ERICA (2019)	1.49E-06	4.21E-06	1.05E-05	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	0.00E+00	-
Cs-137	ERICA (2019)	1.49E-06	9.64E-07	2.45E-06	-
Cu-29	ERICA (2019)	N/A	N/A	N/A	-
I-129	ERICA (2019)	4.57E-07	9.64E-09	2.63E-08	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	7.46E-08	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	1.34E-08	-
Nb-94	ERICA (2019)	1.58E-06	2.72E-06	6.92E-06	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	7.19E-10	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	0.00E+00	-
Np-237	ERICA (2019)	2.41E-04	3.07E-08	6.14E-08	-
Pa-231	ERICA (2019)	2.52E-04	6.26E-08	1.45E-07	-
Pb-210	ERICA (2019)	2.19E-06	2.45E-09	4.56E-09	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	3.77E-11	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	6.31E-10	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	4.56E-12	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	1.01E-08	-
Ra-226	ERICA (2019)	1.18E-03	2.98E-06	7.45E-06	-
Ra-228	ERICA (2019)	3.07E-06	1.67E-06	4.12E-06	-
Sr-90	ERICA (2019)	5.43E-06	1.40E-13	1.05E-12	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	0.00E+00	-
Th-228	ERICA (2019)	1.61E-03	2.54E-06	6.49E-06	-
Th-229	Amiro (1997) (	2.61E-04 *	6.52E-07	6.52E-07	-
Th-230	ERICA (2019)	2.37E-04	6.05E-10	1.58E-09	-
Th-232	ERICA (2019)	2.02E-04	3.68E-10	1.05E-09	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	9.42E-09	-
U-234	ERICA (2019)	2.45E-04	5.87E-10	1.31E-09	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	5.52E-07	-
U-238	ERICA (2019)	2.10E-04	4.12E-10	8.77E-10	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	0.00E+00	-
Meadow Vole					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.19E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.63E-10	-	-
Co-60	ERICA (2019)	1.49E-06	4.21E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	1.49E-06	9.64E-07	-	-
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	4.57E-07	9.64E-09	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	1.58E-06	2.72E-06	-	-
Ni-59	ERICA (2019)	8.13E-08	8.77E-42	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.41E-04	3.07E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	6.26E-08	-	-
Pb-210	ERICA (2019)	2.19E-06	2.45E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.49E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	2.81E-10	-	-
Pu-241	ERICA (2019)	7.07E-08	2.28E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.18E-03	2.98E-06	-	-
Ra-228	ERICA (2019)	3.07E-06	1.66E-06	-	-
Sr-90	ERICA (2019)	5.43E-06	1.40E-13	-	-
Tc-99	ERICA (2019)	5.08E-07	0	-	-
Th-228	ERICA (2019)	1.60E-03	2.54E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	6.05E-10	-	-
Th-232	ERICA (2019)	2.02E-04	3.68E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	5.87E-10	-	-
U-235	ERICA (2019)	2.26E-04	2.54E-07	-	-
U-238	ERICA (2019)	2.10E-04	4.12E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-
Terrestrial Vegetation					
Ac-227	Amiro (1997)	4.61E-06 *	2.14E-08	-	-
Ag-108m	ERICA (2019)	N/A	N/A	-	-
Am-241	ERICA (2019)	2.78E-04	2.89E-08	-	-
Am-243	ERICA (2019)	N/A	N/A	-	-
C-14	ERICA (2019)	2.59E-07	0.00E+00	-	-
Cl-36	ERICA (2019)	1.40E-06	2.75E-10	-	-
Co-60	ERICA (2019)	6.40E-06	4.35E-06	-	-
Cs-135	ERICA (2019)	3.49E-07	0.00E+00	-	-
Cs-137	ERICA (2019)	2.81E-06	1.01E-06	-	-

Radiological COPCs	Reference	Internal	External On-soil	External In-soil	External Water
		Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg	Gy/y per Bq/kg
Cu-29	ERICA (2019)	N/A	N/A	-	-
I-129	ERICA (2019)	5.26E-07	1.67E-08	-	-
Mo-93	Amiro (1997)	8.22E-08	7.46E-08	-	-
Nb-93m	Amiro (1997)	1.53E-07	1.34E-08	-	-
Nb-94	ERICA (2019)	5.08E-06	2.82E-06	-	-
Ni-59	ERICA (2019)	8.06E-08	1.14E-09	-	-
Ni-63	ERICA (2019)	1.08E-07	0.00E+00	-	-
Np-237	ERICA (2019)	2.42E-04	3.68E-08	-	-
Pa-231	ERICA (2019)	2.52E-04	6.93E-08	-	-
Pb-210	ERICA (2019)	2.28E-06	3.51E-09	-	-
Po-210	ERICA (2019)	2.72E-04	1.53E-11	-	-
Pu-239	ERICA (2019)	2.63E-04	5.26E-10	-	-
Pu-241	ERICA (2019)	7.10E-08	2.81E-12	-	-
Pu-242	Amiro (1997)	2.52E-04 *	1.01E-08	-	-
Ra-226	ERICA (2019)	1.23E-03	3.03E-06	-	-
Ra-228	ERICA (2019)	5.20E-06	1.70E-06	-	-
Sr-90	ERICA (2019)	5.70E-06	1.14E-12	-	-
Tc-99	ERICA (2019)	5.08E-07	0.00E+00	-	-
Th-228	ERICA (2019)	1.67E-03	2.56E-06	-	-
Th-229	Amiro (1997)	2.61E-04 *	6.52E-07	-	-
Th-230	ERICA (2019)	2.37E-04	1.23E-09	-	-
Th-232	ERICA (2019)	2.02E-04	9.64E-10	-	-
U-233	Amiro (1997)	2.48E-04 *	9.42E-09	-	-
U-234	ERICA (2019)	2.45E-04	1.23E-09	-	-
U-235	ERICA (2019)	2.26E-04	2.72E-07	-	-
U-238	ERICA (2019)	2.12E-04	8.77E-10	-	-
Zr-93	Amiro (1997)	9.92E-08	0.00E+00	-	-

Notes: * An RBE of 10 was applied.

3.5.2 Non-radiological COPCs

For terrestrial vegetation and earthworms, toxicity is based on direct comparison to soil COPC concentrations; an examination of the intakes for these receptors is not necessary. Similarly, assessment of potential effects on aquatic biota via contact with surface water is based on direct comparison to surface water COPC concentrations and exposure modelling is not required.

For mammals and birds, COPC exposure is based on intakes, which are estimated by way of food chain intake calculations. In a broad sense, the total intake of any given COPC for a particular mammal or bird receptor is equal to the sum of intakes from all appropriate pathways, including: incidental ingestion of soil/sediment, incidental ingestion of surface water, and consumption of food (which varies based on the diet of a particular receptor). Equation 3-9 is used to calculate each of the intake routes as follows:

$$I_n = C_n \times IR_n \times f_{loc} \times CF \qquad (3\text{-}9)$$

where

I_n = intake of COPC via pathway "n" where "n" can represent all exposure routes such as soil, vegetation, etc. [mg/d]

C_n = COPC concentration in "n" medium [mg/kg]

IR_n = intake rate of "n" by the receptor [g/d]

f_{loc} = fraction of time at site [-]

CF = conversion factor $1.0x10^{-3}$ [kg/g].

After summing the individual intakes, the total intake was divided by the body weight of the ecological receptor in order to compare the total COPC intake to the TRV (which has the unit of mg/kg-d). This is consistent with CSA (2012) methodology for calculating intakes.

3.5.3 Transfer Factors

To estimate intake up the food chain, concentrations of COPCs in terrestrial vegetation, seeds, earthworms and small mammals and birds (as prey) were estimated using transfer factors (TFs) from literature sources, as shown in Table 3-10.

The associated tissue concentrations in terrestrial vegetation, seeds and earthworms were estimated from soil concentrations based on transfer factor methodology as shown in Equation 3-10 (CSA 2012):

$$C_{biota} = C_{soil} \times TF_{soil-to-biota} \quad (3\text{-}10)$$

where

C_{biota} = COPC concentration in biota (terrestrial vegetation, seeds, and earthworms) [mg/(kg ww) or Bq/(kg ww)]

C_{soil} = COPC concentration in soil [mg/(kg dw) or Bq/(kg dw)]

TF = transfer factor from soil-to-biota [(mg/(kg ww))/(mg/(kg dw))];
to convert from TF [(mg/(kg dw))/(mg/(kg dw))] to TF [(mg/(kg ww))/(mg/(kg dw))], multiply by (1 - moisture content of biota). Assumed moisture contents were 81% for terrestrial vegetation, 9.3% for seeds and 85% for earthworm.

Similarly, the associated tissue concentrations in aquatic vegetation, benthic invertebrates, zooplankton, frog (tadpole) and fish were estimated from water concentrations as shown in Equation 3-11 (CSA 2012):

$$C_{biota} = C_{water} \times TF_{water-to-biota} \quad (3\text{-}11)$$

where

C_{biota} = COPC concentration in aquatic biota (aquatic vegetation, benthic invertebrates, zooplankton, frog (tadpole) and fish) [mg/(kg ww) or Bq/(kg ww)]

C_{water} = COPC concentration in water [mg/L or Bq/L]

TF = transfer factor from water-to-biota [(mg/(kg ww))/(mg/L)].

In addition, mammalian tissue concentrations were estimated from allometrically scaled feed-to-tissue transfer factors as shown in Equation 3-12 (CSA 2012):

$$C_{tissue} = I_{total} \times TF_{feed-to-tissue} \quad (3\text{-}12)$$

where

C_{tissue} = COPC concentration in tissue of ingested animal (meadow vole, short-tailed shrew, little brown myotis, black bear, white-tailed deer, moose and eastern wolf) [mg/(kg ww) or Bq/(kg ww)]

I_{total} = intake of COPC by ingested animal from all pathways ($\sum I_n$) [mg/d or Bq/d]

$TF_{feed\text{-}to\text{-}tissue}$ = allometrically scaled transfer factor from feed-to-tissue [d/kg]

Snapping turtle tissue concentrations were estimated using the same factors as mammals.

Transfer factors for many COPCs are available from the literature for feed-to-beef (cow), which as noted above, can be allometrically scaled for the ingested animal using the ratio of their body weight to that of the cow as shown in Equation 3-13. This approach was used for all mammals.

$$TF_{sm} = TF_{fb} \times \left(\frac{BW_{sm}}{BW_{cow}} \right)^{-0.75} \quad (3\text{-}13)$$

where

TF_{sm} = feed-to-tissue transfer factor for mammal [d/(kg ww)]

TF_{fb} = feed-to-tissue transfer factor for beef [d/(kg ww)]

BW_{sm} = body weight of mammal [kg]

BW_{cow} = 600, body weight of cow [kg] (N288.1-14 Table G.7, CSA 2018).

Similarly, transfer factors are also available from the literature for feed-to-bird (poultry) that can be allometrically scaled for the ingested birds using the ratio of their body weight to that of the poultry as shown in Equation 3-14. This was used for all birds.

$$TF_{bird} = TF_{poultry} \times \left(\frac{BW_{bird}}{BW_{poultry}} \right)^{-0.75} \quad (3\text{-}14)$$

where

TF_{bird} = feed-to-tissue transfer factor for bird (great blue heron, mallard, bald eagle, ruffed grouse, belted kingfisher, Canada warbler, eastern whip-poor-will and purple finch) [d/(kg ww)]

$TF_{poultry}$ = feed-to-tissue transfer factor for poultry [d/(kg ww)]

BW_{bird} = body weight of bird [kg]

$BW_{poultry}$ = 2, body weight of poultry [kg] (N288.1-14 Table G.7, CSA 2018).

The transfer factors for radiological and non-radiological COPCs that were assessed in the EcoRA are summarized in Table 3-10 and Table 3-11, respectively.

Table 3-10 Transfer Factors for Radiological COPCs

Radionuclide COPCs	Water-to-Aquatic Vegetation TF (L/kg FW) [1]	Water-to-Benthos TF (L/kg FW) [2]	Water-to-Fish TF (L/kg FW) [3]	Soil-to-Earthworm TF (g DW/g DW) [4]	Soil-to-Vegetation TF (g DW/g DW) [6]	Feed-to-Bird TF (d/kg FW) [7]	Feed-to-Mammal TF (d/kg FW) [8]
Ac-227	1.00E+04 [9]	1.00E+03 [6]	2.50E+01 [6]	-	3.50E-03	6.00E-03 [9]	4.00E-04 [9]
Am-241	3.10E+03	1.20E+03	2.40E+02	1.71E+00	6.30E-04	1.20E-03	5.00E-04
C-14	5.90E+03	5.20E+03	5.70E+03	1.35E+03 [11]	9.75E+02 [11]	Specific activity model	
Cl-36	5.00E+01	1.40E+02	4.70E+01	1.11E+00 [5]	8.90E+01	1.75E+00	1.70E-02
Co-60	7.90E+02	1.10E+02	5.40E+01	1.13E-01	4.70E-02	9.70E-01	4.30E-04
Cs-135	2.20E+02	9.90E+01	3.50E+03	5.00E-03	5.30E-02	2.70E+00	2.20E-02
Cs-137	2.20E+02	9.90E+01	3.50E+03	5.00E-03	5.30E-02	2.70E+00	2.20E-02
I-129	7.10E+01	9.60E+00	6.00E+00	9.75E-01 [5]	5.00E-02	8.70E-03	6.70E-03
Mo-93	2.40E+02	3.60E+00	4.60E+02	1.01E+00	3.60E-01	1.80E-01	1.00E-03
Nb-93m	1.20E+03	1.00E+02	3.00E+02	9.56E-01 [5]	2.90E-02	3.00E-04	2.60E-07
Nb-94	1.20E+03	1.00E+02	3.00E+02	9.56E-01 [5]	2.90E-02	3.00E-04	2.60E-07
Ni-59	5.20E+01	1.00E+02	2.10E+01	1.66E+00	4.70E-01	3.10E-01	5.00E-03
Ni-63	5.20E+01	1.00E+02	2.10E+01	1.66E+00	4.70E-01	3.10E-01	5.00E-03
Np-237	1.90E+03	8.20E+02	3.00E+01	1.11E+00 [5]	8.40E-03	3.10E-03	3.80E-04
Pa-231	1.10E+03	1.10E+02	1.00E+01	1.11E+00 [5]	3.80E-02	2.00E-03	1.10E-05
Pb-210	1.90E+03 [10]	2.20E+01 [10]	2.50E+01 [10]	3.07E-01	3.10E-01 [10]	8.00E-01 [9]	7.00E-04 [9]
Po-210	2.00E+03 [9]	2.00E+04 [9]	3.60E+01 [9]	6.23E-02 [5]	6.40E-02 [10]	2.40E+00 [10]	5.00E-03 [10]
Pu-239	4.00E+03	7.20E+02	2.10E+04	2.50E+00	1.40E-04	9.20E-04	1.10E-06
Pu-241	4.00E+03	7.20E+02	2.10E+04	2.50E+00	1.40E-04	9.20E-04	1.10E-06
Pu-242	4.00E+03	7.20E+02	2.10E+04	2.50E+00	1.40E-04	9.20E-04	1.10E-06
Ra-226	2.20E+03	1.10E+02	4.00E+00	2.71E-01 [5]	1.10E-01	3.00E-02	1.70E-03
Ra-228	2.20E+03	1.10E+02	4.00E+00	2.71E-01 [5]	1.10E-01	3.00E-02	1.70E-03
Sr-90	3.70E+02	2.40E+02	2.00E+00	1.17E-01	8.70E-01	2.00E-02	1.30E-03
Tc-99	7.60E+00	9.50E+00	2.00E+01	2.46E+00 [5]	3.70E+00	4.10E-01	9.60E-04
Th-228	1.20E+03	9.00E+02	6.00E+00	5.73E-02 [5]	3.30E-03	1.00E-02	2.30E-04
Th-229	1.20E+03	9.00E+02	6.00E+00	5.73E-02 [5]	3.30E-03	1.00E-02	2.30E-04
Th-230	1.20E+03	9.00E+02	6.00E+00	5.73E-02 [5]	3.30E-03	1.00E-02	2.30E-04
Th-232	1.20E+03	9.00E+02	6.00E+00	5.73E-02 [5]	3.30E-03	1.00E-02	2.30E-04
U-233	3.00E+02	9.90E+01	9.60E-01	3.30E-02	1.00E-02	7.50E-01	3.90E-04
U-234	3.00E+02	9.90E+01	9.60E-01	3.30E-02	1.00E-02	7.50E-01	3.90E-04

Radionuclide COPCs	Water-to-Aquatic Vegetation TF (L/kg FW) [1]	Water-to-Benthos TF (L/kg FW) [2]	Water-to-Fish TF (L/kg FW) [3]	Soil-to-Earthworm TF (g DW/g DW) [4]	Soil-to-Vegetation TF (g DW/g DW) [6]	Feed-to-Bird TF (d/kg FW) [7]	Feed-to-Mammal TF (d/kg FW) [8]
U-235	3.00E+02	9.90E+01	9.60E-01	3.30E-02	1.00E-02	7.50E-01	3.90E-04
U-238	3.00E+02	9.90E+01	9.60E-01	3.30E-02	1.00E-02	7.50E-01	3.90E-04
Zr-93	3.20E+03	3.00E+03	7.00E+00	5.97E-02	3.20E-03	6.00E-05	1.20E-06

Notes:

(1) CSA N288.1-14 (CSA 2018), Table A.25f (freshwater plants).
(2) CSA N288.1-14 (CSA 2018), Table A.25e (freshwater invertebrates, including zooplankton).
(3) CSA N288.1-14 (CSA 2018), Table A.25a (fish muscle for freshwater fish). Also applied to green frog (tadpole).
(4) Sample *et al*. (1998).
(5) ERICA (2019).
(6) CSA N288.1-14 (CSA 2018), Table G.3 (concentration ratios).
(7) CSA N288.1-14 (CSA 2018), Table G.3 (poultry meat).
(8) CSA N288.1-14 (CSA 2018), Table G.3 (beef meat).
(9) Table 2.6, 2.7 and 2.10, Staven *et al.* (2003).
(10) Table 17, 30, 34, 55, 56, IAEA (2010).
(11) Derived using Specific Activity Model.
TF – transfer factor.

Table 3-11 Transfer Factors for Non-radiological COPCs

a) Aquatic Receptors

COPC	Water-to-Fish (Whole) TF (L/kg FW)		Water-to-Aquatic Vegetation TF (L/kg FW)		Sediment-to-Benthos TF (kg sed/kg ww)		Water-to-Benthos TF (L/kg FW)	
	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Aluminum	51	IAEA (2010) (Table 57, muscle)	417	Thompson *et al.* (1972)	0.00039	IAEA (2010) (Table 59, mean)	3400	IAEA (2010) (Table 56)
Copper	270	IAEA (2010) (Table 57, geomean)	3000	IAEA (2010) (Table 55, geomean)	0.47	IAEA (2010) (Table 59, mean)	42	IAEA (2010) (Table 56, geomean)
Lead	370	IAEA (2010) (Table 57, geomean)	1900	IAEA (2010) (Table 55, geomean)	0.0096	IAEA (2010) (Table 59, mean)	22	IAEA (2010) (Table 56, geomean)
Uranium	0.96	CSA (2018) (Table A.25a)	300	CSA (2018) (Table A.25f)	0.017	IAEA (2010) (Table 59, mean)	99	CSA (2018) (Table A.25e)

b) Terrestrial Receptors

COPC	Soil-to-Earthworm TF (kg DW/kg DW)		Soil-to-Vegetation TF (g DW/g DW)		Soil-to-Seed TF (g DW/g DW)		Feed-to-Bird TF (d/kg FW)		Feed-to-Mammal TF (d/kg FW)	
	Value	Reference	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Aluminum	0.039	Sample *et al.* (1998, Table C.1, geomean)	0.004	Baes *et al.* (1984, Fig. 2.1)	0.00065	Baes *et al.* (1984, Fig. 2.2)	0.8	Staven *et al.* (2003)	0.0015	Baes *et al.* (1984, Fig. 2.25, beef)
Copper	0.47	Sample *et al.* (1998) (Table 11, geomean)	0.8	IAEA (2010) (Table 17)	0.8	IAEA (2010) (Table 17)	0.5	IAEA (1994) (Table XIX, poultry)	0.009	IAEA (1994) (Table XV, beef)
Lead	0.31	Sample *et al.* (1998) (Table 11, geomean)	0.31	IAEA (2010) (Table 17, grasses)	0.0053	IAEA (2010); Table 17 (seeds and pods of Leguminous vegetables)	0.4	NCRP (1996)	0.0007	IAEA (2010) (Table 30, beef)
Uranium	0.033	Sample *et al.* (1998, Table C.1, geomean)	0.01	CSA (2018) (Table G.3)	0.01	CSA (2018) (Table G.3)	0.00039	CSA (2018) (Table G.3)	0.75	CSA (2018) (Table G.3)
Moisture Content	84%	Assumed	90%	CSA (2018) Table G.3	9.3%	Assumed				

Notes: TF – transfer factor; DW – dry weight; FW or WW – wet weight.

3.5.3.1 Specific Activity Model for Carbon-14

The plants and animals transfer factors for carbon-14 were estimated using the specific activity approach, as recommended in Clause 7.3.4.3.6 of N288.6-12 (CSA 2012). Aquatic transfer factors for carbon-14 in Tables A.25a, A.25e and A.25f of N288.1-14 (CSA 2018) were derived using the specific activity model as described in Clause 7.7.5 in N288.1-14 (CSA 2018). The average concentration of stable carbon in dissolved inorganic form across the Great Lakes system and rivers is 0.0213 gC/L. The concentrations of stable carbon in freshwater fish, invertebrates and aquatic plants are 122 gC/kg ww, 111 gC/kg ww and 500 gC/kg dw, respectively.

Water to aquatic biota transfer factors for carbon-14 were calculated as follows (equation 7-23 in N288.1-14):

$$TF_{fw-to-aq\ animals} = M_{aa}/M_w \qquad (3\text{-}15)$$

where

$TF_{fw\text{-}to\text{-}aq\ biota}$ = transfer factor from water to aquatic biota (L/kg ww)

M_{aa} = mass of stable carbon in aquatic biota (gC/kg ww)

M_w = mass of stable carbon in the dissolved inorganic phase in water (gC/L).

For aquatic plants, a dry/fresh weight ratio of 0.25 was used to convert the mass of stable carbon from 500 gC/kg dw to 125 gC/kg ww.

Soil to terrestrial biota transfer factors for carbon-14 were not derived in N288.1-14 (CSA 2018). Instead, the specific activity model was used for the transfer of carbon-14 from air to plants and animals that was based on the air concentration, which also accounted for the contribution from soil (Clause 6.4.9.1 in N288.1-14, CSA 2018).

As carbon-14 concentrations in air were not modelled in this study, an alternative approach given by Yu *et al.* (as cited in IAEA 2009) was used for carbon-14 associated with soil solids. The flux of carbon-14 from the soil to the atmosphere is given by:

$$F = C_{soil} \times E_c \times \rho_b \times d_s \qquad (3\text{-}16)$$

where

F = flux of C-14 from soil to air ($Bq/m^2/d$)

C_{soil} = C-14 concentration in soil (Bq/kg dw)

E_c = C-14 evasion loss rate (per d); 0.033 for loam (IAEA 2009)

ρb = soil dry bulk density (kg dw/m^3); 1300 for loam (CSA 2018 Clause 6.3.2.2 and IAEA 2009)

d_s = soil depth (m); assumed 0.2 (CSA 2018 Clause 6.3.1.1).

The specific activity of the carbon evading the soil (SAe, Bq/gC) is given by:

$$SA_e = F/F_c \qquad (3\text{-}17)$$

where

F = flux of C-14 from soil to air (Bq/m^2/d), estimated in above equation

Fc = average production of stable carbon by decomposition of crop residues (gC/m^2/d); suggested value is 0.66 (IAEA 2009).

Assuming that the specific activity of air in the plant canopy is the same as in the soil gas, and modified to account for dilution with uncontaminated air, the specific activity in air is given by:

$$SA_{air} = CD_c \times SA_e \qquad (3\text{-}18)$$

where

SA_{air} = C-14 specific activity in air (Bq/gC)

CDc = canopy dilution factor for C-14 (unitless); 0.15 for crops with an open canopy (forage) (IAEA 2009).

By definition,

$$SA_{air} = \frac{C_{air}}{S_{air}} \qquad (3\text{-}19)$$

where:

S_{air} = concentration of stable carbon in air (gC/m^3); 0.21 (CSA 2018 Clause 6.4.9.3)

C_{air} = concentration of C-14 in air (Bq/m^3).

Hence, C_{air} (concentration of C-14 in air) can be estimated from C_{soil} (concentration of C-14 in soil) by re-arranging the above equations:

$$C_{air} = C_{soil} \times E_c \times \rho_b \times d_s \times CD_c \times S_{air}/F_c \qquad (3\text{-}20)$$

The estimated C-14 concentration in plants based on the equation given in Clause 6.4.9.2 in N288.1-14 (CSA 2018) without the dry/fresh weight conversion is as follows:

$$C_{plant} = C_{air} \times f_{c\_air} \times S_{plant}/S_{air} \qquad (3\text{-}21)$$

where

- C_{plant} = concentration of C-14 in plants (Bq/kg dw)
- C_{air} = concentration of C-14 in air (Bq/m^3)
- f_{c_air} = fraction of plant stable carbon derived from air (unitless); assumed to be 1.0 (CSA 2018 Clause 6.4.9.3)
- S_{plant} = concentration of stable carbon in plant (gC/kg dw); 500 (CSA 2018 Clause 6.4.9.3)
- S_{air} = concentration of stable carbon in air (gC/m^3); 0.21 (CSA 2018 Clause 6.4.9.3).

Combining equations (3-20) and (3-21),

$$C_{plant} = C_{soil} \times E_c \times \rho_b \times d_s \times CD_c \times S_{air}/F_c \times f_{c\_air} \times S_{plant}/S_{air}$$

$$C_{plant} = C_{soil} \times 0.033 \times 1300 \times 0.2 \times 0.15 \times 0.21/0.66 \times 1.0 \times 500/0.21 \quad (3\text{-}22)$$

The soil-to-plant TF for C-14 is estimated to be 975.

Using a similar approach, the specific activity of C-14 (Bq/gC) is assumed to be the same in soil invertebrates as in plants. In the absence of data on stable carbon content in terrestrial invertebrates, a value of 111 gC/kg ww (or 694 gC/kg dw assuming a moisture content of 84%) was used, consistent with the value for marine crustaceans (Table 23 in N288.1-14, CSA 2018). By replacing S_{plant} in equation (3-22) with 694 gC/kg dw, the soil-to-earthworm TF for C-14 is estimated to be 1353.

To derive feed-to-flesh transfer factors for carbon-14, it is assumed that food ingestion pathways contribute most of the carbon intake by ecological receptors, compared to the inhalation, water ingestion and soil/sediment ingestion pathways. Using the specific activity approach,

$$C_{animal} = C_{food} \times S_{animal}/S_{food} = Q_{food} \times C_{food} \times TF_{feed-to-flesh} \quad 3\text{-}23$$

and hence,

$$TF_{feed-to-flesh} = \frac{S_{animal}}{S_{food}}/Q_{food} \quad 3\text{-}24$$

where

- C_{animal} = concentration of C-14 in the animal (Bq/kg ww)
- C_{feed} = concentration of C-14 in the food (Bq/kg ww)
- S_{animal} = concentration of stable carbon in the animal (gC/kg ww); 244 for birds and 201 for mammals (CSA 2018 Table 18 for beef and poultry)

S_{food} = concentration of stable carbon in food in the animal's diet (gC/kg ww); based on weighted average of the stable carbon concentration of the individual food items in the animal's diet

Q_{food} = food intake rate (kg ww/d); based on ecological receptor characteristics

$TF_{feed\text{-}to\text{-}flesh}$ = feed-to-animal transfer factor (d/kg ww).

The concentrations of stable carbon by food type are given in Table 3-12 and the estimated $TF_{feed\text{-}to\text{-}flesh}$ for C-14 are shown in Table 3-13.

Table 3-12 Stable Carbon Concentration by Food Types

Food Type	Stable Carbon Concentration (gC/kg ww)	Reference
Aquatic Vegetation	50	CSA 2018, converted from 500 gC/kg dw assuming a moisture content of 90%
Birds	244	CSA 2018, for poultry
Benthic Invertebrates	111	CSA 2018, for marine crustacea
Earthworms	111	CSA 2018, for marine crustacea
Fish	122	CSA 2018
Mammals	201	CSA 2018, for beef
Seeds	454	CSA 2018, converted from 500 gC/kg dw assuming a moisture content of 9.3%
Terrestrial Vegetation	100	CSA 2018, converted from 500 gC/kg dw assuming a moisture content of 80%

Table 3-13 Estimated Feed-to-Flesh Transfer Factors for Carbon-14

Receptor	S_{animal}	Food Intake	Fraction of Food Type in Diet (with stable carbon concentration in gC/kg ww)									S_{food}	TF
	(gC/kg ww)	(kg ww/d)	Seeds	Terrestrial Vegetation	Aquatic Vegetation	Benthic Invertebrates	Fish	Earthworms	Deer	Birds	Small Mammals	(gC/kg ww)	d/kg ww
Bald eagle	244	0.564					0.65			0.15	0.2	156.1	2.77E+00
Belted kingfisher	244	0.0775					1					122	2.58E+01
Canada warbler	244	0.0088						1				111	2.50E+02
Eastern Whip-poor-will	244	0.0246						1				111	8.94E+01
Great blue heron	244	0.414				0.1	0.65				0.25	140.7	4.19E+00
Mallard	244	0.3		0.05	0.5	0.4	0.025	0.025				80.2	1.01E+01
Purple finch	244	0.00562	1									454	9.56E+01
Ruffed grouse	244	0.125		0.85				0.15				101.7	1.92E+01
Black bear	201	6.8		0.8			0.05	0.05			0.1	111.8	2.65E-01
Little brown myotis	201	0.006				0.5		0.5				111	3.02E+02
Meadow vole	201	0.0115		1								100	1.75E+02
Short-tailed shrew	201	0.009						1				111	2.01E+02
White-tailed deer	201	7.5		1								100	2.68E-01
Eastern wolf	201	5.5							0.2		0.8	201	1.82E-01
Moose	201	53.3		0.8	0.2							90	4.19E-02
Snapping turtle	201	0.18			0.4		0.6					93.2	1.20E+01

4 EFFECTS ASSESSMENT

4.1 Radiological Benchmarks

A benchmark value is a level of exposure (concentration or dose) below which meaningful effects are unlikely and above which there is a potential for meaningful effects (CSA 2012). Ecological risks are assessed by estimating the total dose rate received by an ecological receptor and comparing it to the selected benchmark.

The recommended radiological dose benchmarks from CSA N288.6-12 (CSA 2012), which are based on UNSCEAR (2008) (2.4 mGy/d for terrestrial biota and 9.6 mGy/d for aquatic biota), were used in this study for terrestrial biota and aquatic biota located in Perch Creek. For more information on the rationale for selecting these benchmarks, the reader is referred to the CSA (2012) document. It is noted that part of the Ottawa River is located in the Province of Quebec, which has a radiological benchmark for aquatic biota (10 µGy/hr or 0.24 mGy/d) 40 times lower than that recommended by CSA N288.6-12 (CSA 2012). Thus, for aquatic species located in the Ottawa River, the more restrictive Quebec benchmark of 0.24 mGy/d was applied (MELCC 2020).

Table 4-1 presents the final radiological dose benchmarks selected for both aquatic and terrestrial biota. A safety factor of 10 was applied to the benchmarks for species at risk to assess risks at the individual as opposed to population level.

Table 4-1 Radiological Dose Benchmarks (mGy/d)

Major Biota Group	Organism	Dose Rate Benchmark
Aquatic Vegetation	Reed	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Pelagic Invertebrate Community	Zooplankton	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Benthic Invertebrate Community	Benthic Invertebrates	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Benthic Fish	Bluntnose Minnow, Brown Bullhead	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Pelagic Fish	Northern Pike	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Amphibians	Green Frog (tadpole)	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Aquatic Based Birds	Belted Kingfisher, Great Blue Heron, Mallard	9.6 mGy/d (Perch Creek)[1] 0.24 mGy/d (Ottawa River)[2]
Aquatic Based Mammals	Moose	2.4 mGy/d[1]
Terrestrial Vegetation	Red Maple	2.4 mGy/d[1]
Soil Invertebrates	Earthworm	2.4 mGy/d[1]
Terrestrial Based Birds	Purple Finch, Ruffed Grouse	2.4 mGy/d[1]
Terrestrial Based Small and Large Mammals	Meadow Vole, Short-tailed Shrew, Black Bear, White-tailed Deer	2.4 mGy/d[1]

Major Biota Group	Organism	Dose Rate Benchmark
Species at Risk		
Aquatic Reptiles	Snapping Turtle	0.96 mGy/d (Perch Creek)[1,3] 0.024 mGy/d (Ottawa River)[2,3]
Terrestrial Based Birds	Canada Warbler, Eastern Whip-poor-will	0.24 mGy/d[1,3]
Terrestrial Based Small and Large Mammals	Little Brown Myotis, Eastern Wolf	0.24 mGy/d[1,3]

Notes:

(1) Canadian Standards Association (CSA). 2012. *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*. N288.6-12. June; United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). 2008. *Sources and Effects of Ionizing Radiation*, *Annex E: Effects of Ionizing Radiation on Non-Human Biota*.

(2) Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC). 2020. *Surface Water Quality Criteria.* Retrieved from the MELCC webpage: http://www.environnement.gouv.qc.ca/eau/criteres_eau/index.asp; protection of aquatic life, chronic effect, for exposure to radionuclides.

(3) A safety factor of 10 was applied to the benchmark for species at risk.

4.2 Toxicological Benchmarks

Overall, ecological toxicity benchmark values for non-radiological COPCs were obtained based on the following hierarchies of sources. These hierarchies include credible, recognized references that are used in EcoRAs as common industry practice. The hierarchies generally incorporate CSA N288.6-12 guidance (CSA 2012) but in cases where N288.6-12 sources were considered outdated, values from more recent credible sources were used preferentially (with supporting rationale). More detailed descriptions of the methodologies used in selecting these toxicity benchmark values are presented in the following subsections.

Aquatic Biota (Fish, Aquatic Vegetation and Aquatic Invertebrates):

1. U.S. EPA ECOTOX Database
2. Suter and Tsao (1996)
3. CCME (1995, 2003, 2019)
4. Other

Aquatic Birds:

1. U.S. EPA Ecological Soil Screening Levels (Eco-SSLs)
2. Sample *et al.* (1996)
3. OMOE (2011a)

Terrestrial Vegetation & Invertebrates:

1. OMOE (2011a) values protective of soil invertebrates and plants, based on residential land use
2. CCME supporting documents for Canadian Soil Quality Guidelines
3. U.S. EPA Eco-SSLs
4. Environment Canada (2013) Database of Guidelines

Mammals & Terrestrial Birds:

4. U.S. EPA Eco-SSLs
5. Sample *et al.* (1996)
6. OMOE (2011a)

4.2.1 Aquatic Invertebrates, Vegetation, and Fish

In selecting the TRVs for aquatic biota, toxicity data were primarily obtained from the U.S. EPA ECOTOX database, and water quality objectives/criteria from the CCME and U.S. EPA. The ECOTOX database reports toxicity data for a wide range of aquatic species as well as laboratory and field studies. For most chemicals, ECOTOX includes toxicity data in the literature from 1972 to the present. All data have been quality assured according to the U.S. EPA's criteria, and the system is updated quarterly. CSA (2012) also supports the use of ECOTOX as a source of information. The following principles were applied in the data selection:

- Endpoints involving growth, reproduction and survival were considered to be relevant to persistence of aquatic populations (consistent with CSA 2012);
- Only freshwater toxicity studies were considered;
- Records without test duration, endpoint and exposure concentration were eliminated;
- Chronic toxicity data were preferred in the selection (favoured by CSA 2012 as well). When chronic data were not sufficient (minimum of 2), acute data were considered and converted to chronic values;
- Chronic EC20 concentrations were preferred (consistent with CSA 2012). If not reported, other endpoints were considered and adjusted to an estimated EC20 value.

Table 4-2 presents the TRV values selected for aquatic biota.

Table 4-2 Toxicity Reference Values for Aquatic Biota (mg/L)

COPC	Final TRV	Ecological Receptor	Reference	Comments
Aluminum (Al)	4.7	Fish (benthic)	U.S. DOE (2005)	EC_{20} Fish Surface Water Screening Benchmark.
	3.29	Fish (pelagic) and tadpole	U.S. DOE (2005)	Lowest Chronic Value Fish Surface Water Screening Benchmark.
	18.28	Aquatic Vegetation	Gostomoski (1990) cited in Gensmer and Playle (1999)	*Myriophyllum;* EC_{50} (growth); used EC_{20} – pH 7.6-8.2.
	0.32	Benthic Invertebrates	Borgmann *et al.* (1980) cited in CCME (2003)	14-d EC_{20}.
	0.26	Zooplankton	Wakabayashi *et al.* (1988) cited in U.S. EPA ECOTOX	*Daphnia* sp.; 24-h LC_{50}; derived benchmark using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}.
Copper (Cu)	0.0056	Fish (benthic)	Various references cited in U.S. EPA ECOTOX	5th percentile of estimated chronic EC_{20} values from U.S. EPA ECOTOX; 11 studies are included in the 5th percentile.
	0.004	Fish (pelagic) and tadpole	Various references cited in U.S. EPA ECOTOX	5th percentile of estimated chronic EC_{20} values from U.S. EPA ECOTOX; 6 studies are included in the 5th percentile.
	0.038	Aquatic Vegetation	Various references cited in U.S. EPA ECOTOX	5th percentile of estimated chronic EC_{20} values from U.S. EPA ECOTOX.
	0.002	Benthic Invertebrates	CCME (2019)	Used CCME value since calculated EC_{20} was less than CCME value; water hardness < 82 mg/L $CaCO_3$.
	0.002	Zooplankton	CCME (2019)	Used CCME value since calculated EC_{20} was less than CCME value; water hardness < 82 mg/L $CaCO_3$.
Lead (Pb)	0.132	Fish (benthic)	Spehar and Fiandt (1986) cited in U.S. EPA ECOTOX	*Pimephales promelas;* lowest value from U.S. EPA ECOTOX; 32-d EC_{50}; TRV derived from EC_{50} by linear extrapolation.
	0.0142	Fish (pelagic) and tadpole	Various references cited in U.S. EPA ECOTOX	Various species; 5th percentile of estimated chronic EC_{20} values from U.S. EPA ECOTOX.
	0.439	Aquatic Vegetation	Gaur *et al.* (1994) cited in U.S. EPA ECOTOX	*Spirodela polyrhiza;* lowest value from U.S. EPA ECOTOX; 4-d EC_{50} (population); TRV derived from EC_{50} by linear extrapolation.
	0.001	Benthic Invertebrates	CCME (2019)	CCME water quality guideline for the protection of freshwater aquatic life; water hardness ≤ 60 mg/L $CaCO_3$.
	0.040	Zooplankton	Biesinger and Christensen (1972) cited in U.S. EPA ECOTOX	*Daphnia magna;* lowest value from U.S. EPA ECOTOX; 21-d EC_{50} (reproduction); TRV derived from EC_{50} by linear extrapolation.

COPC	Final TRV	Ecological Receptor	Reference	Comments
Uranium (U)	1.5	Fish (benthic)	Vizon SciTec (2004)	Fathead minnow; lowest estimated chronic EC_{20}.
	0.55	Fish (pelagic) and tadpole	Vizon SciTec (2004)	Rainbow trout; lowest estimated chronic EC_{20}; LC_{25} (survival) assumed equivalent to EC_{20}; water hardness of 60 mg/L $CaCO_3$.
	5.5	Aquatic Vegetation	Vizon SciTec (2004)	*Lemna minor;* geometric mean of 2 EC_{25} (growth) values; assumed equivalent to EC_{20}; water hardness of 60 mg/L $CaCO_3$.
	0.027	Benthic Invertebrates	Liber *et al.* (2007)	*Hyallela Azteca*; lowest estimated chronic EC_{25}; 28-d EC_{25} (growth) assumed equivalent to EC_{20}; water hardness of 60 mg/L $CaCO_3$.
	0.06	Zooplankton	Vizon SciTec (2004)	*Ceriodaphnia dubia;* lowest estimated chronic EC_{20}; water hardness of 60 mg/L $CaCO_3$.

Notes: NV – no value.

4.2.2 Aquatic Birds

In selecting the TRVs for aquatic birds, values were primarily obtained from the U.S. EPA risk-based ecological soil screening levels (Eco-SSLs) and from Sample *et al*. (1996). The selected values for aquatic birds are shown in Table 4-3.

Table 4-3 Toxicity Reference Values for Aquatic Birds (mg/kg-d)

COPCs	Final TRV	Ecological Receptor	Comments
Aluminum (Al)	109.7 (NOAEL)	Belted Kingfisher Mallard Great Blue Heron	Carriere *et al.* (1986) cited in Sample *et al.* (1996) Based on a single study NOAEL (LOAEL not available); ringed dove.
Copper (Cu)	75.2 (LOAEL)		Foster (1999) Geometric mean of 3 LOAEL values; mallard.
Lead (Pb)	1.13 (NOAEL) 11.3 (LOAEL)		Edens *et al.* (1976) cited in Sample *et al.* (1996); Japanese quail.
Uranium (U)	16 (NOAEL)		Haseltine and Sileo (1983) cited in Sample *et al.* (1996) Based on a single study NOAEL (LOAEL not available); black duck.

4.2.3 Terrestrial Invertebrates and Vegetation

In selecting the TRVs for terrestrial vegetation and invertebrates (earthworms), a review was conducted of the Ontario Ministry of the Environment rationale document (OMOE 2011a), the soil quality standards of the CCME, the Eco-SSL documents of the U.S. EPA, along with values from the Environment Canada (2013) Database of Guidelines. The selected values are shown in Table 4-4.

The OMOE (2011a) considered ecotoxicity criteria in the development of soil criteria, so that soil standards are protective of both human and ecological health. In the OMOE (2011a) update of their soil criteria, plant and soil invertebrate protection values for agricultural/residential/parkland and industrial/commercial land use were developed following the CCME (1996) protocol using current scientific literature data on toxicity to agricultural crops, native plant species and soil dwelling organisms. The level of protection for plants and soil organisms is typically less stringent for commercial/industrial land use than for agricultural/ residential/parkland land use (OMOE 2011a). However, in following the CCME (1996) protocol, this was problematic for no/lowest observable effects concentration (NOEC/LOEC) data (a combined NOEC/LOEC dataset was used for the agricultural/residential/parkland derivation, while an LOEC-only dataset was used for the commercial/industrial derivation, which can throw out useful information and thereby drive the value down). To solve this issue, OMOE (2011a) used a combined NOEC/LOEC dataset for both land uses, and selected the 25th and 50th percentile values as the agricultural/residential/parkland and industrial/ commercial protection values, respectively. In situations where a value for plant and soil organism protection could not be developed for industrial/commercial land use, OMOE (2011a) applied a factor of 2 to the agricultural/residential/parkland value. OMOE (2011a) considered this approach to be sufficiently protective for an industrial/commercial setting. It was determined that the above-described OMOE approach was appropriate for use in the current assessment and thus, the OMOE (2011a) values for protection of plants and soil invertebrates were selected as the TRVs when available.

Following the above methodology, OMOE (2011a) was able to develop component values for 20 constituents. OMOE (2011a) also reviewed information from other jurisdictions and found that CCME ecological protection numbers and the numbers developed by the Netherlands would provide a suitable level of protection for Ontario. The Netherlands criteria were derived using the 50th percentile of the "No Observed Effect Distribution" (NOEC) of the data.

Table 4-4 Toxicity Reference Values for Terrestrial Plants & Earthworms (mg/kg)

COPC	Earthworm	Plants
	Residential/ Parkland/ Institutional [1]	Residential/ Parkland/ Institutional [1]
Aluminum (Al)	50 [2]	50 [2]
Copper (Cu)	140	140
Lead (Pb)	250	250
Uranium (U)	500	500

Notes:
[1] OMOE (2011a) - Appendix A2, Soil Components for Table 3 – Full Depth, Non-potable Water Scenario, Coarse Textured Soil.
[2] Environment Canada (2013) Database of Guidelines.

4.2.4 Mammals and Terrestrial Birds

In selecting the TRVs for terrestrial mammals and birds, values were primarily obtained from the U.S. EPA Eco-SSLs, and from Sample *et al*. (1996). Data from OMOE (2011a) were then used to infill any remaining data gaps.

Dose-based TRVs for wildlife were chosen from a review of data presented in the documentation of U.S. EPA Eco-SSLs for most analytes, and literature studies were reviewed for chronic dose values for analytes without Eco-SSL data. Endpoints involving growth and reproduction were considered to be relevant to assessment of wildlife populations. TRVs were derived preferentially from LOAEL data. The use of LOAELs is consistent with CSA (2012), which states that selected benchmarks should correspond to the lowest exposure levels (e.g., LOAELs) associated with adverse effects. A comparison was made to mortality-based endpoints to ensure that the derived TRV does not exceed a mortality endpoint. Where available, the LOAELs were paired with NOAELs for reference purposes.

In general, if three or more LOAEL data were available for a test species, then the geometric mean of the LOAEL data was calculated and used as the TRV for the given test species (assuming other conditions (above) were met). Otherwise, the lowest bounded LOAEL value was used.

An important aspect of TRV selection and derivation is the avoidance of allometric scaling. Historically, the results of toxicity tests on laboratory animals which were typically limited to test species, were adjusted for other species by applying allometric equations for weight differences between test species and species of interest in the assessment. More recently, the allometric weight adjustment was found to be inappropriate for most analytes and ecological receptors.

In the present risk assessment, the lowest species LOAEL in the case of mammals or birds was selected as the TRV, which is a very conservative approach. An exception is noted for mammalian and avian species at risk (i.e., little brown myotis, eastern wolf, Canada warbler, and eastern whip-poor-will), which warrant an additional level of protection. For this reason, the TRV selection process for species at risk relied on bounded-NOAEL data, not LOAEL data, and endpoints of mortality and reproduction were not included. Thus, where available, the use of bounded-NOAEL data as opposed to LOAEL data – which are typically higher and are used to determine potential effects – were selected as TRVs providing this additional level of conservatism and protection.

Table 4-5 presents the selected TRVs for mammals and Table 4-6 the selected TRVs for birds.

Table 4-5 Toxicity Reference Values for Mammals (mg/kg/d)

COPCs	Final TRV	Ecological Receptor	Comments
Aluminum (Al)	1.93 (NOAEL) 19.3 (LOAEL)	Little Brown Myotis * Meadow Vole Short-tailed Shrew White-tailed Deer Eastern Wolf * Black Bear Moose	Ondreicka *et al.* (1966) cited in Sample *et al.* (1996); based on mouse.
Copper (Cu)	5.6 (NOAEL) 8.8 (LOAEL)		LOAEL is the lowest derived species geometric mean (pig) based on 4 values. NOAEL is based on a single value for the species (pig).
Lead (Pb)	10.7 (NOAEL) 14.1 (LOAEL)		LOAEL is the lowest derived species geometric mean (mouse) based on 7 values. NOAEL is the lowest species value (rabbit) based on a single value.
Uranium (U)	5.6 (NOAEL) 6.13 (LOAEL)		Paternain *et al.* (1989) cited correctly in ATSDR (2011) LOAEL and NOAEL each based on a single value for the mouse.

Notes: * Species at risk.

Table 4-6 Toxicity Reference Values for Terrestrial Based Birds (mg/kg/d)

COPCs	Final TRV	Ecological Receptor	Comments
Aluminum (Al)	109.7 (NOAEL)	Canada Warbler * Purple Finch Ruffed Grouse Eastern Whip-poor-will * Bald Eagle	Carriere *et al*. (1986) cited in Sample *et al.* (1996); NOAEL based on ringed dove; LOAEL is not available.
Copper (Cu)	15.3 (NOAEL) 27.0 (LOAEL)		LOAEL is the lowest derived species geometric mean (turkey) based on 9 values; 90 data points were considered for 3 species (chicken, duck and turkey). NOAEL is the lowest derived species geometric mean (turkey) based on 5 values; 61 data points were considered covering 3 species (chicken, duck, and turkey).
Lead (Pb)	1.13 (NOAEL) 11.3 (LOAEL)		Edens *et al.* (1976) cited ins Sample *et al.* (1996); based on Japanese quail.
Uranium (U)	16 (NOAEL)		Haseltine and Sileo (1983) cited in Sample *et al.* (1996) NOAEL is based on a single value for the black duck; LOAEL is not available.

Notes: * Species at risk.

5 RISK CHARACTERIZATION

5.1 Screening Index Values

Ecological risks were assessed by calculating screening index (SI) values, comparing the estimated exposures to the toxicity and radiation benchmarks outlined in Section 4. Screening index values provide an integrated description of the potential hazard, the exposure (or dose) response relationship and the exposure evaluation (U.S. EPA 1992; AIHC 1992). For exposure to radionuclides, the SI was calculated by dividing the total dose rate by the selected benchmark value for each ecological receptor, as shown in Equation 5-1.

$$Screening\ \ Index = \frac{Dose\ \ Rate}{Dose\ \ Rate\ \ Guideline} \quad (5\text{-}1)$$

For exposure to non-radionuclides, the SI was calculated by dividing the expected exposure or dose concentration by the selected benchmark toxicity value for each ecological receptor, as shown in Equation 5-2.

$$Screening\ \ Index = \frac{Intake}{Toxicity\ \ Benchmark} \quad (5\text{-}2)$$

The SI values reported are not estimates of the probability of ecological impact. Rather, the index values are positively correlated with the potential of an impact, i.e., higher index values imply greater potential for an impact although this relationship is not linear and varies widely among contaminants. Different magnitudes of the SI have been used in other studies to screen for potential ecological effects. An SI value of 1.0 has been used in some instances (e.g., Suter 1991). In other work, Cadwell *et al.* (1993) suggested an index value of 0.3, based upon a conservative approach designed to account for potential chronic toxicity and chemical synergism. In this study, an index value of 1.0 was used to examine the potential negative effects of COPCs for aquatic and terrestrial receptors.

As noted in Section 2.3, the assessment of species at risk is different in that these species are assessed at the individual rather than the population level. The SI was calculated in the same way noted above but the benchmarks were adjusted to be protective at the individual level. For instance, for terrestrial wildlife, NOAEL rather than LOAEL TRVs were used when available, or a safety factor of 10 was applied to the LOAEL TRV. Radiological benchmarks were adjusted by a factor of 10.

This next section presents the radiological and non-radiological SIs calculated for each ecological receptor-COPC combination during the post-closure phase of the project. Sample calculations for radiological doses, chemical intakes and SI values are provided in Appendix B.

5.1.1 Radiological COPCs

The risk results (SIs) for radiological dose for all of the post-closure scenarios are summarized in tables as follows:

- Table 5-1 for aquatic receptors exposed in either the Ottawa River (Receptor 1) or Perch Creek (Receptor 2).
- Table 5-2 for aquatic based receptors with small home ranges that are exposed from sources predominantly associated with either the Ottawa River (Receptor 1) or Perch Creek (Receptor 2), as well as the Grazing Area for exposure via terrestrial sources.
- Table 5-3 for terrestrial based receptors with small home ranges that are exposed from sources predominantly associated with either the Grazing Area (Receptor 1) or the Garden Area (Receptor 2), as well as Perch Creek for exposure via aquatic sources; the earthworm exposed via soil (Garden Area or Grazing Area) is also included here.
- Table 5-4 for birds and mammals with large home ranges that utilize the entire site (sitewide) and that obtain half of their exposure via aquatic sources from the Ottawa River and the other half from Perch Creek; and half of their exposure via terrestrial sources from the Grazing Area and the other half from the Garden Area. The exception to this occurs for scenarios (4) and (14) where sitewide receptors are assumed to obtain all (100%) of their terrestrial exposure from the Grazing Area as contaminant concentrations in soil were not predicted for the Garden Area in these scenarios.

The tables include radiological dose estimates along with the corresponding dose benchmarks for terrestrial and aquatic receptors, as well as SI comparisons.

Table 5-1 Radiological Risk Screening Index Results for Aquatic Receptors in the Ottawa River and Perch Creek

Scenario	Ottawa River (Receptor 1)						Perch Creek (Receptor 2)					
	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)
Benchmark (mGy/d)	0.24	0.24	0.24	0.24	0.24	0.24	9.6	9.6	9.6	9.6	9.6	9.6
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions												
Total Dose (mGy/d)	6.46E-08	3.03E-07	1.28E-08	3.03E-07	1.28E-08	3.03E-07	4.93E-05	2.32E-04	9.97E-06	2.31E-04	9.76E-06	2.32E-04
SI (-)	2.69E-07	1.26E-06	5.33E-08	1.26E-06	5.33E-08	1.26E-06	5.13E-06	2.41E-05	1.04E-06	2.41E-05	1.02E-06	2.41E-05
(1a) NES Sensitivity Analysis: Inventory Sensitivity												
Total Dose (mGy/d)	9.52E-04	4.34E-03	6.27E-04	4.34E-03	6.27E-04	7.22E-06	7.28E-01	3.31E+00	4.84E-01	3.31E+00	4.82E-01	6.02E-03
SI (-)	3.97E-03	1.81E-02	2.61E-03	1.81E-02	2.61E-03	3.01E-05	7.58E-02	3.45E-01	5.04E-02	3.45E-01	5.02E-02	6.27E-04
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity												
Total Dose (mGy/d)	6.46E-08	3.03E-07	1.28E-08	3.03E-07	1.28E-08	3.03E-07	4.93E-05	2.32E-04	9.97E-06	2.31E-04	9.76E-06	2.32E-04
SI (-)	2.69E-07	1.26E-06	5.33E-08	1.26E-06	5.33E-08	1.26E-06	5.13E-06	2.41E-05	1.04E-06	2.41E-05	1.02E-06	2.41E-05
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity												
Total Dose (mGy/d)	3.27E-04	1.12E-03	4.35E-04	1.12E-03	4.35E-04	2.97E-06	2.50E-01	8.59E-01	3.35E-01	8.59E-01	3.35E-01	2.34E-03
SI (-)	1.36E-03	4.67E-03	1.81E-03	4.67E-03	1.81E-03	1.24E-05	2.61E-02	8.94E-02	3.49E-02	8.94E-02	3.49E-02	2.44E-04
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek												
Total Dose (mGy/d)	6.97E-08	3.29E-07	1.37E-08	3.29E-07	1.37E-08	3.29E-07	5.32E-05	2.51E-04	1.06E-05	2.51E-04	1.04E-05	2.51E-04
SI (-)	2.90E-07	1.37E-06	5.71E-08	1.37E-06	5.71E-08	1.37E-06	5.54E-06	2.62E-05	1.11E-06	2.62E-05	1.09E-06	2.62E-05
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner												
Total Dose (mGy/d)	1.09E-07	5.38E-07	2.05E-08	5.38E-07	2.05E-08	5.38E-07	8.31E-05	4.11E-04	1.58E-05	4.11E-04	1.56E-05	4.11E-04
SI (-)	4.54E-07	2.24E-06	8.54E-08	2.24E-06	8.54E-08	2.24E-06	8.65E-06	4.28E-05	1.64E-06	4.28E-05	1.63E-06	4.28E-05
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER												
Total Dose (mGy/d)	5.36E-08	2.51E-07	1.06E-08	2.51E-07	1.05E-08	2.51E-07	4.09E-05	1.92E-04	8.21E-06	1.91E-04	8.04E-06	1.92E-04
SI (-)	2.23E-07	1.05E-06	4.42E-08	1.05E-06	4.38E-08	1.05E-06	4.26E-06	2.00E-05	8.55E-07	1.99E-05	8.38E-07	2.00E-05
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)												
Total Dose (mGy/d)	6.46E-08	3.03E-07	1.28E-08	3.03E-07	1.28E-08	3.03E-07	4.93E-05	2.32E-04	9.97E-06	2.31E-04	9.76E-06	2.32E-04
SI (-)	2.69E-07	1.26E-06	5.33E-08	1.26E-06	5.33E-08	1.26E-06	5.13E-06	2.41E-05	1.04E-06	2.41E-05	1.02E-06	2.41E-05
(4) Disruptive Event: Enhanced Corrosion Case												
Total Dose (mGy/d)	8.07E-08	3.04E-07	1.88E-08	3.04E-07	1.86E-08	3.04E-07	3.49E-05	9.33E-05	9.41E-06	9.31E-05	9.23E-06	9.33E-05
SI (-)	3.36E-07	1.27E-06	7.83E-08	1.27E-06	7.75E-08	1.27E-06	3.63E-06	9.72E-06	9.80E-07	9.70E-06	9.61E-07	9.72E-06
(5) Disruptive Event: Localized Cover Failure												
Total Dose (mGy/d)	5.61E-08	2.58E-07	1.14E-08	2.58E-07	1.14E-08	2.58E-07	4.29E-05	1.97E-04	8.92E-06	1.97E-04	8.71E-06	1.97E-04
SI (-)	2.34E-07	1.08E-06	4.75E-08	1.08E-06	4.75E-08	1.08E-06	4.47E-06	2.05E-05	9.30E-07	2.05E-05	9.07E-07	2.05E-05
(6) Disruptive Event: Localized Liner Failure												
Total Dose (mGy/d)	7.35E-08	3.25E-07	1.76E-08	3.25E-07	1.74E-08	3.25E-07	5.61E-05	2.49E-04	1.41E-05	2.48E-04	1.33E-05	2.49E-04
SI (-)	3.06E-07	1.35E-06	7.33E-08	1.35E-06	7.25E-08	1.35E-06	5.84E-06	2.59E-05	1.46E-06	2.59E-05	1.39E-06	2.59E-05
(7) Disruptive Event: Damage to Berm												
Total Dose (mGy/d)	6.59E-08	3.09E-07	1.31E-08	3.09E-07	1.31E-08	3.09E-07	5.04E-05	2.36E-04	1.02E-05	2.36E-04	9.98E-06	2.36E-04
SI (-)	2.75E-07	1.29E-06	5.46E-08	1.29E-06	5.46E-08	1.29E-06	5.25E-06	2.46E-05	1.06E-06	2.46E-05	1.04E-06	2.46E-05
(8) Dose Optimization: Wastes Grouted into Steel Liners												
Total Dose (mGy/d)	6.45E-08	3.03E-07	1.28E-08	3.03E-07	1.28E-08	3.03E-07	4.93E-05	2.32E-04	9.97E-06	2.32E-04	9.76E-06	2.32E-04
SI (-)	2.69E-07	1.26E-06	5.33E-08	1.26E-06	5.33E-08	1.26E-06	5.13E-06	2.42E-05	1.04E-06	2.41E-05	1.02E-06	2.42E-05
(11) Defence-in-Depth: Role of Geosphere												
Total Dose (mGy/d)	9.08E-08	3.70E-07	1.65E-08	3.70E-07	1.65E-08	3.70E-07	6.94E-05	2.85E-04	1.45E-05	2.83E-04	1.26E-05	2.85E-04
SI (-)	3.78E-07	1.54E-06	6.88E-08	1.54E-06	6.88E-08	1.54E-06	7.23E-06	2.97E-05	1.51E-06	2.95E-05	1.31E-06	2.97E-05
(12) Defence-in-Depth: Role of Cover												
Total Dose (mGy/d)	1.74E-07	8.71E-07	3.31E-08	8.71E-07	3.30E-08	8.71E-07	1.33E-04	6.66E-04	2.55E-05	6.65E-04	2.52E-05	6.66E-04
SI (-)	7.25E-07	3.63E-06	1.38E-07	3.63E-06	1.38E-07	3.63E-06	1.38E-05	6.93E-05	2.66E-06	6.93E-05	2.63E-06	6.93E-05

Scenario	Ottawa River (Receptor 1)						Perch Creek (Receptor 2)					
	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)
Benchmark (mGy/d)	0.24	0.24	0.24	0.24	0.24	0.24	9.6	9.6	9.6	9.6	9.6	9.6
(13) Defence-in-Depth: Role of Base Liner												
Total Dose (mGy/d)	6.39E-08	2.67E-07	1.63E-08	2.67E-07	1.61E-08	2.67E-07	4.88E-05	2.05E-04	1.31E-05	2.04E-04	1.23E-05	2.05E-04
SI (-)	2.66E-07	1.11E-06	6.79E-08	1.11E-06	6.71E-08	1.11E-06	5.08E-06	2.13E-05	1.37E-06	2.13E-05	1.28E-06	2.13E-05
(14) Defence-in-Depth: Series of Landslides												
Total Dose (mGy/d)	1.33E-07	3.11E-07	5.26E-08	3.10E-07	5.15E-08	3.11E-07	9.29E-05	2.36E-04	3.51E-05	2.36E-04	3.48E-05	2.36E-04
SI (-)	5.54E-07	1.30E-06	2.19E-07	1.29E-06	2.15E-07	1.30E-06	9.68E-06	2.46E-05	3.66E-06	2.45E-05	3.63E-06	2.46E-05
(15) "What-If": Human Intrusion, Mass Excavation and Farming [1]												
Total Dose (mGy/d)	9.48E-04	2.12E-03	4.12E-03	2.12E-03	4.12E-03	2.38E-05	7.27E-01	1.62E+00	3.18E+00	1.62E+00	3.18E+00	1.84E-02
SI (-)	3.95E-03	8.83E-03	1.72E-02	8.83E-03	1.72E-02	9.92E-05	7.58E-02	1.69E-01	3.31E-01	1.69E-01	3.31E-01	1.92E-03
(17) "What-If": Permanent Bathtub [1]												
Total Dose (mGy/d)	7.40E-08	3.04E-07	1.55E-08	3.04E-07	1.54E-08	3.04E-07	5.65E-05	2.32E-04	1.22E-05	2.32E-04	1.17E-05	2.32E-04
SI (-)	3.08E-07	1.27E-06	6.46E-08	1.27E-06	6.42E-08	1.27E-06	5.88E-06	2.42E-05	1.27E-06	2.41E-05	1.22E-06	2.42E-05

Notes:

Bold – value exceeds the SI benchmark value of 1.

(1) There are no criteria for 'What-If' scenarios and thus screening index (SI) values are only provided for perspective.

Table 5-2 Radiological Risk Screening Index Results for Aquatic Based Receptors (small home range)

Scenario	Ottawa River (Receptor 1)				Perch Creek (Receptor 2)			
	Belted Kingfisher	Great Blue Heron	Mallard	Snapping Turtle *	Belted Kingfisher	Great Blue Heron	Mallard	Snapping Turtle *
Benchmark (mGy/d)	0.24	0.24	0.24	0.024	9.6	9.6	9.6	0.96
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions								
Total Dose (mGy/d)	1.54E-10	8.69E-10	5.94E-09	3.76E-11	1.31E-07	7.76E-08	3.24E-07	2.08E-07
SI (-)	6.42E-10	3.62E-09	2.48E-08	1.57E-09	1.37E-08	8.08E-09	3.38E-08	2.17E-07
(1a) NES Sensitivity Analysis: Inventory Sensitivity								
Total Dose (mGy/d)	1.17E-05	2.16E-03	8.83E-04	9.81E-06	9.07E-03	3.82E-02	1.73E-01	8.09E-03
SI (-)	4.88E-05	9.00E-03	3.68E-03	4.09E-04	9.45E-04	3.98E-03	1.80E-02	8.43E-03
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity								
Total Dose (mGy/d)	1.54E-10	8.69E-10	5.94E-09	3.76E-11	1.31E-07	7.76E-08	3.24E-07	2.08E-07
SI (-)	6.42E-10	3.62E-09	2.48E-08	1.57E-09	1.37E-08	8.08E-09	3.38E-08	2.17E-07
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity								
Total Dose (mGy/d)	5.91E-06	5.96E-04	4.04E-04	5.32E-06	4.59E-03	2.86E-02	1.39E-01	4.19E-03
SI (-)	2.46E-05	2.48E-03	1.68E-03	2.22E-04	4.78E-04	2.98E-03	1.45E-02	4.36E-03
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek								
Total Dose (mGy/d)	1.67E-10	8.76E-10	5.95E-09	3.82E-11	1.41E-07	8.28E-08	3.35E-07	2.10E-07
SI (-)	6.96E-10	3.65E-09	2.48E-08	1.59E-09	1.47E-08	8.62E-09	3.49E-08	2.19E-07
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner								
Total Dose (mGy/d)	2.68E-10	8.03E-10	5.00E-09	3.11E-11	2.19E-07	1.18E-07	3.28E-07	1.70E-07
SI (-)	1.12E-09	3.35E-09	2.08E-08	1.30E-09	2.28E-08	1.23E-08	3.42E-08	1.77E-07
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER								
Total Dose (mGy/d)	1.28E-10	8.15E-10	5.58E-09	3.03E-11	1.10E-07	6.62E-08	2.88E-07	1.71E-07
SI (-)	5.33E-10	3.40E-09	2.33E-08	1.26E-09	1.15E-08	6.89E-09	3.00E-08	1.78E-07
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)								
Total Dose (mGy/d)	1.54E-10	8.69E-10	5.94E-09	3.76E-11	1.31E-07	7.76E-08	3.24E-07	2.08E-07
SI (-)	6.42E-10	3.62E-09	2.48E-08	1.57E-09	1.37E-08	8.08E-09	3.38E-08	2.17E-07
(4) Disruptive Event: Enhanced Corrosion Case								
Total Dose (mGy/d)	1.57E-10	6.00E-10	4.07E-09	2.12E-10	6.70E-08	5.15E-08	3.97E-07	1.92E-07
SI (-)	6.54E-10	2.50E-09	1.70E-08	8.83E-09	6.98E-09	5.37E-09	4.13E-08	2.00E-07
(5) Disruptive Event: Localized Cover Failure								
Total Dose (mGy/d)	1.32E-10	8.48E-10	5.84E-09	4.06E-11	1.14E-07	6.95E-08	3.20E-07	2.20E-07
SI (-)	5.50E-10	3.53E-09	2.43E-08	1.69E-09	1.19E-08	7.24E-09	3.33E-08	2.29E-07
(6) Disruptive Event: Localized Liner Failure								
Total Dose (mGy/d)	1.66E-10	7.80E-10	5.29E-09	1.11E-10	1.43E-07	8.63E-08	3.83E-07	7.40E-07
SI (-)	6.92E-10	3.25E-09	2.20E-08	4.63E-09	1.49E-08	8.99E-09	3.98E-08	7.71E-07
(7) Disruptive Event: Damage to Berm								
Total Dose (mGy/d)	1.57E-10	9.30E-10	6.40E-09	4.04E-11	1.32E-07	7.76E-08	3.12E-07	2.16E-07
SI (-)	6.54E-10	3.88E-09	2.67E-08	1.68E-09	1.38E-08	8.08E-09	3.25E-08	2.25E-07
(8) Dose Optimization: Wastes Grouted into Steel Liners								
Total Dose (mGy/d)	1.54E-10	8.70E-10	5.94E-09	3.75E-11	1.31E-07	7.77E-08	3.24E-07	2.08E-07
SI (-)	6.42E-10	3.63E-09	2.48E-08	1.56E-09	1.37E-08	8.09E-09	3.38E-08	2.17E-07
(11) Defence-in-Depth: Role of Geosphere								
Total Dose (mGy/d)	1.87E-10	8.86E-10	5.98E-09	6.43E-11	1.60E-07	9.24E-08	3.59E-07	1.91E-06
SI (-)	7.79E-10	3.69E-09	2.49E-08	2.68E-09	1.66E-08	9.62E-09	3.74E-08	1.99E-06
(12) Defence-in-Depth: Role of Cover								
Total Dose (mGy/d)	4.30E-10	1.03E-09	6.18E-09	5.62E-11	3.44E-07	1.77E-07	3.52E-07	3.02E-07
SI (-)	1.79E-09	4.29E-09	2.58E-08	2.34E-09	3.58E-08	1.84E-08	3.67E-08	3.15E-07

Scenario	Ottawa River (Receptor 1)				Perch Creek (Receptor 2)			
	Belted Kingfisher	Great Blue Heron	Mallard	Snapping Turtle *	Belted Kingfisher	Great Blue Heron	Mallard	Snapping Turtle *
Benchmark (mGy/d)	0.24	0.24	0.24	0.024	9.6	9.6	9.6	0.96
(13) Defence-in-Depth: Role of Base Liner								
Total Dose (mGy/d)	1.38E-10	8.53E-11	4.73E-10	1.29E-10	1.22E-07	7.62E-08	3.80E-07	7.94E-07
SI (-)	5.75E-10	3.55E-10	1.97E-09	5.38E-09	1.27E-08	7.93E-09	3.96E-08	8.27E-07
(14) Defence-in-Depth: Series of Landslides								
Total Dose (mGy/d)	1.76E-10	1.54E-09	1.10E-08	1.07E-09	1.44E-07	1.13E-07	9.84E-07	2.88E-07
SI (-)	7.33E-10	6.42E-09	4.58E-08	4.46E-08	1.50E-08	1.18E-08	1.02E-07	3.00E-07
(15) "What-If": Human Intrusion, Mass Excavation and Farming [1]								
Total Dose (mGy/d)	5.61E-05	9.27E-03	4.37E-03	5.36E-05	4.34E-02	3.10E-01	1.51E+00	4.16E-02
SI (-)	2.34E-04	3.86E-02	1.82E-02	2.23E-03	4.52E-03	3.23E-02	1.57E-01	4.33E-02
(17) "What-If": Permanent Bathtub [1]								
Total Dose (mGy/d)	1.53E-10	9.18E-10	6.45E-09	9.27E-11	1.27E-07	7.32E-08	2.92E-07	4.21E-07
SI (-)	6.38E-10	3.83E-09	2.69E-08	3.86E-09	1.32E-08	7.63E-09	3.04E-08	4.38E-07

Notes:
Bold – value exceeds the SI benchmark value of 1.
(1) There are no criteria for 'What-If' scenarios and thus screening index (SI) values are only provided for perspective.
* Species at Risk.

Table 5-3 Radiological Risk Screening Index Results for Terrestrial Based Receptors (small home range)

Scenario	Grazing Area (Receptor 1)							Garden Area (Receptor 2)						
	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation
Benchmark (mGy/d)	0.24	2.4	2.4	2.4	2.4	2.4	2.4	0.24	2.4	2.4	2.4	2.4	2.4	2.4
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions														
Total Dose (mGy/d)	2.21E-05	2.19E-05	2.16E-05	2.11E-05	2.11E-05	6.51E-05	2.28E-05	5.12E-10	4.75E-10	3.49E-10	1.21E-11	1.99E-11	0.00E+00	0.00E+00
SI (-)	9.20E-05	9.11E-06	9.00E-06	8.81E-06	8.80E-06	2.71E-05	9.49E-06	2.13E-09	1.98E-10	1.46E-10	5.05E-12	8.30E-12	0.00E+00	0.00E+00
(1a) NES Sensitivity Analysis: Inventory Sensitivity														
Total Dose (mGy/d)	1.33E-02	1.16E-02	1.13E-02	1.09E-02	7.79E-03	1.19E-01	1.75E-02	5.75E-02	5.75E-02	5.75E-02	4.74E-02	4.74E-02	2.53E-02	2.36E-02
SI (-)	5.56E-02	4.84E-03	4.71E-03	4.53E-03	3.24E-03	4.95E-02	7.28E-03	2.40E-01	2.39E-02	2.40E-02	1.97E-02	1.97E-02	1.05E-02	9.82E-03
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity														
Total Dose (mGy/d)	2.21E-05	2.19E-05	2.16E-05	2.11E-05	2.11E-05	6.51E-05	2.28E-05	5.12E-10	4.75E-10	3.49E-10	1.21E-11	1.99E-11	0.00E+00	0.00E+00
SI (-)	9.20E-05	9.11E-06	9.00E-06	8.81E-06	8.80E-06	2.71E-05	9.49E-06	2.13E-09	1.98E-10	1.46E-10	5.05E-12	8.30E-12	0.00E+00	0.00E+00
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity														
Total Dose (mGy/d)	8.26E-03	6.76E-03	6.36E-03	6.44E-03	3.83E-03	4.48E-02	1.33E-02	5.76E-03	5.75E-03	5.76E-03	4.74E-03	4.74E-03	2.53E-03	2.36E-03
SI (-)	3.44E-02	2.82E-03	2.65E-03	2.68E-03	1.60E-03	1.87E-02	5.56E-03	2.40E-02	2.40E-03	2.40E-03	1.98E-03	1.98E-03	1.05E-03	9.82E-04
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek														
Total Dose (mGy/d)	2.21E-05	2.19E-05	2.16E-05	2.11E-05	2.11E-05	6.51E-05	2.28E-05	5.28E-10	4.91E-10	3.61E-10	1.25E-11	2.06E-11	0.00E+00	0.00E+00
SI (-)	9.20E-05	9.11E-06	9.00E-06	8.81E-06	8.80E-06	2.71E-05	9.49E-06	2.20E-09	2.04E-10	1.50E-10	5.21E-12	8.57E-12	0.00E+00	0.00E+00
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner														
Total Dose (mGy/d)	1.03E-05	1.01E-05	9.89E-06	9.49E-06	9.47E-06	2.86E-05	1.03E-05	5.03E-10	4.67E-10	3.43E-10	1.20E-11	1.97E-11	0.00E+00	0.00E+00
SI (-)	4.28E-05	4.21E-06	4.12E-06	3.95E-06	3.95E-06	1.19E-05	4.28E-06	2.09E-09	1.94E-10	1.43E-10	4.98E-12	8.19E-12	0.00E+00	0.00E+00
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER														
Total Dose (mGy/d)	1.78E-05	1.76E-05	1.73E-05	1.69E-05	1.69E-05	5.29E-05	1.82E-05	4.54E-10	4.22E-10	3.10E-10	1.08E-11	1.77E-11	0.00E+00	0.00E+00
SI (-)	7.40E-05	7.32E-06	7.21E-06	7.03E-06	7.02E-06	2.20E-05	7.58E-06	1.89E-09	1.76E-10	1.29E-10	4.49E-12	7.38E-12	0.00E+00	0.00E+00
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)														
Total Dose (mGy/d)	2.21E-05	2.19E-05	2.16E-05	2.11E-05	2.11E-05	6.51E-05	2.28E-05	7.05E-07	6.86E-07	6.60E-07	6.16E-07	6.14E-07	2.39E-06	6.71E-07
SI (-)	9.20E-05	9.11E-06	9.00E-06	8.81E-06	8.80E-06	2.71E-05	9.49E-06	2.94E-06	2.86E-07	2.75E-07	2.57E-07	2.56E-07	9.94E-07	2.79E-07
(4) Disruptive Event: Enhanced Corrosion Case														
Total Dose (mGy/d)	1.02E-05	1.01E-05	9.89E-06	9.59E-06	9.57E-06	3.10E-05	1.04E-05	6.38E-10	5.92E-10	4.35E-10	1.66E-11	2.72E-11	0.00E+00	0.00E+00
SI (-)	4.25E-05	4.19E-06	4.12E-06	3.99E-06	3.99E-06	1.29E-05	4.32E-06	2.66E-09	2.47E-10	1.81E-10	6.90E-12	1.13E-11	0.00E+00	0.00E+00
(5) Disruptive Event: Localized Cover Failure														
Total Dose (mGy/d)	2.35E-05	2.33E-05	2.30E-05	2.26E-05	2.26E-05	6.69E-05	2.43E-05	5.09E-10	4.72E-10	3.47E-10	1.20E-11	1.98E-11	0.00E+00	0.00E+00
SI (-)	9.80E-05	9.71E-06	9.60E-06	9.41E-06	9.40E-06	2.79E-05	1.01E-05	2.12E-09	1.97E-10	1.45E-10	5.01E-12	8.24E-12	0.00E+00	0.00E+00
(6) Disruptive Event: Localized Liner Failure														
Total Dose (mGy/d)	1.68E-05	1.67E-05	1.64E-05	1.60E-05	1.60E-05	4.97E-05	1.73E-05	6.09E-10	5.65E-10	4.16E-10	1.43E-11	2.36E-11	0.00E+00	0.00E+00
SI (-)	7.01E-05	6.94E-06	6.84E-06	6.67E-06	6.66E-06	2.07E-05	7.19E-06	2.54E-09	2.36E-10	1.73E-10	5.97E-12	9.82E-12	0.00E+00	0.00E+00
(7) Disruptive Event: Damage to Berm														
Total Dose (mGy/d)	2.62E-05	2.60E-05	2.57E-05	2.52E-05	2.52E-05	8.02E-05	2.71E-05	4.91E-10	4.55E-10	3.35E-10	1.17E-11	1.92E-11	0.00E+00	0.00E+00
SI (-)	1.09E-04	1.08E-05	1.07E-05	1.05E-05	1.05E-05	3.34E-05	1.13E-05	2.04E-09	1.90E-10	1.39E-10	4.86E-12	7.99E-12	0.00E+00	0.00E+00
(9) Dose Optimization: Wastes Grouted into Steel Liners														
Total Dose (mGy/d)	2.21E-05	2.19E-05	2.16E-05	2.12E-05	2.11E-05	6.52E-05	2.28E-05	5.12E-10	4.76E-10	3.50E-10	1.21E-11	1.99E-11	0.00E+00	0.00E+00
SI (-)	9.21E-05	9.12E-06	9.01E-06	8.81E-06	8.81E-06	2.72E-05	9.50E-06	2.13E-09	1.98E-10	1.46E-10	5.04E-12	8.29E-12	0.00E+00	0.00E+00
(11) Defence-in-Depth: Role of Geosphere														
Total Dose (mGy/d)	2.21E-05	2.19E-05	2.16E-05	2.11E-05	2.11E-05	6.51E-05	2.28E-05	5.41E-10	5.02E-10	3.69E-10	1.52E-11	2.50E-11	0.00E+00	0.00E+00
SI (-)	9.20E-05	9.11E-06	9.00E-06	8.81E-06	8.80E-06	2.71E-05	9.49E-06	2.25E-09	2.09E-10	1.54E-10	6.33E-12	1.04E-11	0.00E+00	0.00E+00

(12) Defence-in-Depth: Role of Cover														

Scenario	Grazing Area (Receptor 1)							Garden Area (Receptor 2)						
	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation
Benchmark (mGy/d)	0.24	2.4	2.4	2.4	2.4	2.4	2.4	0.24	2.4	2.4	2.4	2.4	2.4	2.4
Total Dose (mGy/d)	2.98E-05	2.96E-05	2.93E-05	2.88E-05	2.88E-05	8.31E-05	3.10E-05	5.18E-10	4.81E-10	3.53E-10	1.23E-11	2.03E-11	0.00E+00	0.00E+00
SI (-)	1.24E-04	1.23E-05	1.22E-05	1.20E-05	1.20E-05	3.46E-05	1.29E-05	2.16E-09	2.00E-10	1.47E-10	5.14E-12	8.45E-12	0.00E+00	0.00E+00
(13) Defence-in-Depth: Role of Base Liner														
Total Dose (mGy/d)	1.22E-09	1.17E-09	1.01E-09	5.99E-10	6.08E-10	1.72E-09	6.29E-10	6.14E-10	5.70E-10	4.19E-10	1.46E-11	2.40E-11	0.00E+00	0.00E+00
SI (-)	5.07E-09	4.87E-10	4.22E-10	2.50E-10	2.54E-10	7.17E-10	2.62E-10	2.56E-09	2.38E-10	1.75E-10	6.09E-12	1.00E-11	0.00E+00	0.00E+00
(14) Defence-in-Depth: Series of Landslides														
Total Dose (mGy/d)	1.91E-05	1.87E-05	1.83E-05	1.74E-05	1.74E-05	5.84E-05	1.89E-05	1.66E-09	1.54E-09	1.13E-09	3.94E-11	6.47E-11	0.00E+00	0.00E+00
SI (-)	7.96E-05	7.81E-06	7.61E-06	7.26E-06	7.25E-06	2.43E-05	7.87E-06	6.93E-09	6.43E-10	4.73E-10	1.64E-11	2.70E-11	0.00E+00	0.00E+00
(15) "What-If": Human Intrusion, Mass Excavation and Farming [1]														
Total Dose (mGy/d)	2.67E-02	2.64E-02	2.63E-02	2.26E-02	2.15E-02	4.18E-02	1.34E-02	6.60E-03	6.41E-03	6.37E-03	5.50E-03	5.09E-03	1.70E-02	4.13E-03
SI (-)	1.11E-01	1.10E-02	1.10E-02	9.41E-03	8.96E-03	1.74E-02	5.57E-03	2.75E-02	2.67E-03	2.65E-03	2.29E-03	2.12E-03	7.08E-03	1.72E-03
(17) "What-If": Permanent Bathtub [1]														
Total Dose (mGy/d)	3.43E-05	3.40E-05	3.37E-05	3.33E-05	3.32E-05	1.01E-04	3.58E-05	4.50E-10	4.18E-10	3.07E-10	1.19E-11	1.96E-11	0.00E+00	0.00E+00
SI (-)	1.43E-04	1.42E-05	1.41E-05	1.39E-05	1.38E-05	4.21E-05	1.49E-05	1.88E-09	1.74E-10	1.28E-10	4.96E-12	8.16E-12	0.00E+00	0.00E+00

Notes:

Bold – value exceeds the SI benchmark value of 1.

(1) There are no criteria for 'What-If' scenarios and thus screening index (SI) values are only provided for perspective.

* Species at Risk.

Table 5-4 Radiological Risk Screening Index Results for Sitewide Receptors (large home range)

Scenario	Sitewide						
	Bald Eagle	Black Bear	Little Brown Myotis *	Eastern Whip-poor-will *	Eastern Wolf *	Moose	White-tailed Deer
Benchmark (mGy/d)	2.4	2.4	0.24	0.24	0.24	2.4	2.4
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions							
Total Dose (mGy/d)	1.07E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05
SI (-)	4.44E-06	4.40E-06	4.40E-05	4.42E-05	4.40E-05	4.40E-06	4.40E-06
(1a) NES Sensitivity Analysis: Inventory Sensitivity							
Total Dose (mGy/d)	1.95E-02	2.62E-02	2.62E-02	3.34E-02	2.69E-02	2.71E-02	2.74E-02
SI (-)	8.11E-03	1.09E-02	1.09E-01	1.39E-01	1.12E-02	1.13E-01	1.14E-02
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity							
Total Dose (mGy/d)	1.07E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05
SI (-)	4.44E-06	4.40E-06	4.40E-05	4.42E-05	4.40E-05	4.40E-06	4.40E-06
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity							
Total Dose (mGy/d)	4.42E-03	4.08E-03	1.20E-02	5.15E-03	5.52E-03	3.85E-03	4.07E-03
SI (-)	1.84E-03	1.70E-03	5.00E-02	2.15E-02	2.30E-03	1.60E-02	1.70E-03
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek							
Total Dose (mGy/d)	1.07E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05
SI (-)	4.45E-06	4.40E-06	4.40E-05	4.42E-05	4.40E-05	4.40E-06	4.40E-06
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner							
Total Dose (mGy/d)	4.85E-06	4.74E-06	4.74E-06	4.78E-06	4.74E-06	4.75E-06	4.74E-06
SI (-)	2.02E-06	1.98E-06	1.97E-05	1.99E-05	1.97E-05	1.98E-06	1.97E-06
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER							
Total Dose (mGy/d)	8.53E-06	8.43E-06	8.43E-06	8.48E-06	8.43E-06	8.44E-06	8.43E-06
SI (-)	3.55E-06	3.51E-06	3.51E-05	3.53E-05	3.51E-05	3.52E-06	3.51E-06
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)							
Total Dose (mGy/d)	1.10E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05	1.09E-05
SI (-)	4.58E-06	4.53E-06	4.53E-05	4.55E-05	4.53E-05	4.53E-06	4.53E-06
(4) Disruptive Event: Enhanced Corrosion Case							
Total Dose (mGy/d)	4.85E-06	4.79E-06	4.79E-06	4.82E-06	4.79E-06	4.82E-06	4.79E-06
SI (-)	2.02E-06	2.00E-06	2.00E-05	2.01E-05	2.00E-05	2.01E-06	1.99E-06
(5) Disruptive Event: Localized Cover Failure							
Total Dose (mGy/d)	1.14E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05	1.13E-05
SI (-)	4.75E-06	4.70E-06	4.70E-05	4.72E-05	4.70E-05	4.71E-06	4.70E-06
(6) Disruptive Event: Localized Liner Failure							
Total Dose (mGy/d)	8.10E-06	8.00E-06	8.00E-06	8.04E-06	8.00E-06	8.01E-06	8.00E-06
SI (-)	3.37E-06	3.33E-06	3.33E-05	3.35E-05	3.33E-05	3.34E-06	3.33E-06
(7) Disruptive Event: Damage to Berm							
Total Dose (mGy/d)	1.27E-05	1.26E-05	1.26E-05	1.26E-05	1.26E-05	1.26E-05	1.26E-05
SI (-)	5.29E-06	5.25E-06	5.24E-05	5.27E-05	5.25E-05	5.25E-06	5.25E-06
(8) Dose Optimization: Wastes Grouted into Steel Liners							
Total Dose (mGy/d)	1.07E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05
SI (-)	4.45E-06	4.41E-06	4.40E-05	4.42E-05	4.40E-05	4.41E-06	4.40E-06
(11) Defence-in-Depth: Role of Geosphere							
Total Dose (mGy/d)	1.07E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05	1.06E-05
SI (-)	4.45E-06	4.40E-06	4.40E-05	4.42E-05	4.40E-05	4.41E-06	4.40E-06
(12) Defence-in-Depth: Role of Cover							
Total Dose (mGy/d)	1.46E-05	1.44E-05	1.44E-05	1.45E-05	1.44E-05	1.44E-05	1.44E-05
SI (-)	6.07E-06	6.01E-06	6.00E-05	6.03E-05	6.01E-05	6.01E-06	6.00E-06

Scenario	Sitewide						
	Bald Eagle	Black Bear	Little Brown Myotis *	Eastern Whip-poor-will *	Eastern Wolf *	Moose	White-tailed Deer
Benchmark (mGy/d)	2.4	2.4	0.24	0.24	0.24	2.4	2.4
(13) Defence-in-Depth: Role of Base Liner							
Total Dose (mGy/d)	1.96E-08	5.19E-10	2.41E-09	5.45E-10	3.17E-10	1.52E-08	3.17E-10
SI (-)	8.17E-09	2.16E-10	1.01E-08	2.27E-09	1.32E-09	6.35E-09	1.32E-10
(14) Defence-in-Depth: Series of Landslides							
Total Dose (mGy/d)	8.88E-06	8.70E-06	8.70E-06	8.79E-06	8.70E-06	8.72E-06	8.70E-06
SI (-)	3.70E-06	3.63E-06	3.62E-05	3.66E-05	3.63E-05	3.64E-06	3.62E-06
(15) "What-If": Human Intrusion, Mass Excavation and Farming [1]							
Total Dose (mGy/d)	1.88E-02	1.33E-02	1.06E-01	1.61E-02	2.74E-02	1.30E-02	1.31E-02
SI (-)	7.82E-03	5.54E-03	4.43E-01	6.70E-02	1.14E-02	5.44E-02	5.46E-03
(17) "What-If": Permanent Bathtub [1]							
Total Dose (mGy/d)	1.67E-05	1.66E-05	1.66E-05	1.67E-05	1.66E-05	1.66E-05	1.66E-05
SI (-)	6.97E-06	6.93E-06	6.92E-05	6.94E-05	6.92E-05	6.93E-06	6.92E-06

Notes:
Bold – value exceeds the SI benchmark value of 1.
(1) There are no criteria for 'What-If' scenarios and thus screening index (SI) values are only provided for perspective.
* Species at Risk.

5.1.2 Non-Radiological COPCs

The risk results (SIs) for non-radiological dose for all post-closure scenarios are summarized in tables as follows:

- Table 5-5 for aquatic receptors exposed to surface water in either the Ottawa River (Receptor 1) or Perch Creek (Receptor 2).
- Table 5-6 for aquatic birds that are exposed from sources predominantly associated with either the Ottawa River (Receptor 1) or Perch Creek (Receptor 2), as well as the Grazing Area for exposure via terrestrial sources.
- Table 5-7 for terrestrial based receptors with small home ranges that are exposed from sources predominantly associated with either the Grazing Area (Receptor 1) or the Garden Area (Receptor 2), as well as Perch Creek for exposure via aquatic sources; the earthworm exposed via soil (Garden Area or Grazing Area) is also included here.
- Table 5-8 for birds and mammals with large home ranges that utilize the entire site (sitewide) and that obtain half of their exposure via aquatic sources from the Ottawa River and the other half from Perch Creek; and half of their exposure via terrestrial sources from the Grazing Area and the other half from the Garden Area. The exception to this occurs for scenarios (4) and (14) where sitewide receptors are assumed to obtain all (100%) of their terrestrial exposure from the Grazing Area as contaminant concentrations in soil were not predicted for the Garden Area in these scenarios.

Sample calculations for chemical intakes and SI values are provided in Appendix B.

Table 5-5 Non-Radiological Risk Screening Index Results for Aquatic Receptors in the Ottawa River and Perch Creek

Post-closure Scenario & COPC	Ottawa River (Receptor 1)						Perch Creek (Receptor 2)					
	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	8.42E+00	5.93E-01	2.10E-01	5.93E-01
Uranium	3.79E-20	1.39E-19	7.71E-18	3.79E-19	3.47E-18	3.79E-19	3.98E-05	1.46E-04	8.11E-03	3.98E-04	3.65E-03	3.98E-04
(1a) NES Sensitivity Analysis: Inventory Sensitivity												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	8.42E+00	5.93E-01	2.10E-01	5.93E-01
Uranium	7.73E-08	2.83E-07	1.57E-05	7.73E-07	7.09E-06	7.73E-07	6.99E-05	2.56E-04	1.42E-02	6.99E-04	6.41E-03	6.99E-04
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	8.42E+00	5.93E-01	2.10E-01	5.93E-01
Uranium	3.79E-08	1.39E-07	7.71E-06	3.79E-07	3.47E-06	3.79E-07	3.98E-05	1.46E-04	8.11E-03	3.98E-04	3.65E-03	3.98E-04
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.84E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	2.00E-02	6.64E-02	8.77E+00	6.17E-01	2.19E-01	6.17E-01
Uranium	9.10E-08	3.34E-07	1.85E-05	9.10E-07	8.34E-06	9.10E-07	8.04E-05	2.95E-04	1.64E-02	8.04E-04	7.37E-03	8.04E-04
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	8.43E+00	5.93E-01	2.11E-01	5.93E-01
Uranium	3.89E-08	1.43E-07	7.93E-06	3.89E-07	3.57E-06	3.89E-07	4.06E-05	1.49E-04	8.27E-03	4.06E-04	3.72E-03	4.06E-04
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.86E-02	6.18E-02	8.16E+00	5.74E-01	2.04E-01	5.74E-01
Uranium	3.73E-08	1.37E-07	7.59E-06	3.73E-07	3.42E-06	3.73E-07	3.94E-05	1.44E-04	8.02E-03	3.94E-04	3.61E-03	3.94E-04
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.90E-02	6.32E-02	8.35E+00	5.88E-01	2.09E-01	5.88E-01
Uranium	3.42E-08	1.25E-07	6.97E-06	3.42E-07	3.14E-06	3.42E-07	3.70E-05	1.36E-04	7.54E-03	3.70E-04	3.39E-03	3.70E-04
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	8.42E+00	5.93E-01	2.10E-01	5.93E-01
Uranium	3.79E-08	1.39E-07	7.71E-06	3.79E-07	3.47E-06	3.79E-07	3.98E-05	1.46E-04	8.11E-03	3.98E-04	3.65E-03	3.98E-04
(4) Disruptive Event: Enhanced Corrosion Case												
Aluminum	1.14E-02	4.45E-02	6.53E-01	6.35E-02	8.04E-01	6.35E-02	1.34E-02	5.20E-02	7.63E-01	7.42E-02	9.40E-01	7.42E-02
Copper	8.02E-02	5.44E-01	1.52E+00	7.62E-01	1.52E+00	7.62E-01	1.05E+00	7.09E+00	1.99E+01	9.93E+00	1.99E+01	9.93E+00
Lead	6.84E-03	2.28E-02	3.00E+00	2.11E-01	7.51E-02	2.11E-01	2.34E-02	7.79E-02	1.03E+01	7.25E-01	2.57E-01	7.25E-01
Uranium	4.69E-08	1.72E-07	9.56E-06	4.69E-07	4.30E-06	4.69E-07	4.67E-05	1.71E-04	9.51E-03	4.67E-04	4.28E-03	4.67E-04
(5) Disruptive Event: Localized Cover Failure												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	8.43E+00	5.93E-01	2.11E-01	5.93E-01
Uranium	3.77E-08	1.38E-07	7.67E-06	3.77E-07	3.45E-06	3.77E-07	3.97E-05	1.45E-04	8.08E-03	3.97E-04	3.64E-03	3.97E-04
(6) Disruptive Event: Localized Liner Failure												
Copper	7.89E-02	5.36E-01	1.50E+00	7.50E-01	1.50E+00	7.50E-01	1.11E-01	7.50E-01	2.10E+00	1.05E+00	2.10E+00	1.05E+00
Lead	6.83E-03	2.27E-02	3.00E+00	2.11E-01	7.50E-02	2.11E-01	1.89E-02	6.29E-02	8.30E+00	5.85E-01	2.08E-01	5.85E-01
Uranium	4.54E-08	1.66E-07	9.24E-06	4.54E-07	4.16E-06	4.54E-07	4.56E-05	1.67E-04	9.28E-03	4.56E-04	4.18E-03	4.56E-04

Post-closure Scenario & COPC	Ottawa River (Receptor 1)						Perch Creek (Receptor 2)					
	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)	Aquatic Vegetation	Benthic Fish	Benthic Invertebrates	Pelagic Fish	Zooplankton	Green Frog (tadpole)
(7) Disruptive Event: Damage to Berm												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.84E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	1.93E-02	6.42E-02	**8.47E+00**	5.97E-01	2.12E-01	5.97E-01
Uranium	3.62E-08	1.33E-07	7.38E-06	3.62E-07	3.32E-06	3.62E-07	3.86E-05	1.41E-04	7.86E-03	3.86E-04	3.54E-03	3.86E-04
(8) Dose Optimization: Wastes Grouted into Steel Liners												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.83E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	1.92E-02	6.38E-02	**8.42E+00**	5.93E-01	2.10E-01	5.93E-01
Uranium	3.52E-08	1.29E-07	7.17E-06	3.52E-07	3.23E-06	3.52E-07	3.78E-05	1.39E-04	7.70E-03	3.78E-04	3.46E-03	3.78E-04
(11) Defence-in-Depth: Role of Geosphere												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.84E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	2.02E-02	6.73E-02	**8.89E+00**	6.26E-01	2.22E-01	6.26E-01
Uranium	3.98E-08	1.46E-07	8.11E-06	3.98E-07	3.65E-06	3.98E-07	4.13E-05	1.51E-04	8.42E-03	4.13E-04	3.79E-03	4.13E-04
(12) Defence-in-Depth: Role of Cover												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.84E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	1.93E-02	6.40E-02	**8.45E+00**	5.95E-01	2.11E-01	5.95E-01
Uranium	3.82E-08	1.40E-07	7.77E-06	3.82E-07	3.50E-06	3.82E-07	4.01E-05	1.47E-04	8.16E-03	4.01E-04	3.67E-03	4.01E-04
(13) Defence-in-Depth: Role of Base Liner												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.83E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	1.88E-02	6.26E-02	**8.26E+00**	5.82E-01	2.06E-01	5.82E-01
(14) Defence-in-Depth: Series of Landslides												
Aluminum	3.49E-02	1.36E-01	**1.99E+00**	1.94E-01	**2.45E+00**	1.94E-01	**1.79E+01**	**6.97E+01**	**1.02E+03**	**9.95E+01**	**1.26E+03**	**9.95E+01**
Copper	8.66E-02	5.88E-01	**1.65E+00**	8.23E-01	**1.65E+00**	8.23E-01	**5.40E+00**	**3.66E+01**	**1.03E+02**	**5.13E+01**	**1.03E+02**	**5.13E+01**
Lead	6.87E-03	2.28E-02	**3.01E+00**	2.12E-01	7.54E-02	2.12E-01	4.30E-02	1.43E-01	**1.89E+01**	**1.33E+00**	4.72E-01	**1.33E+00**
Uranium	1.17E-07	4.31E-07	2.39E-05	1.17E-06	1.08E-05	1.17E-06	9.97E-05	3.66E-04	2.03E-02	9.97E-04	9.14E-03	9.97E-04
(15) "What-If": Human Intrusion, Mass Excavation and Farming [1]												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.83E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	2.21E-02	7.36E-02	**9.72E+00**	6.85E-01	2.43E-01	6.85E-01
Uranium	7.51E-08	2.75E-07	1.53E-05	7.51E-07	6.88E-06	7.51E-07	6.82E-05	2.50E-04	1.39E-02	6.82E-04	6.25E-03	6.82E-04
(17) "What-If": Permanent Bathtub [1]												
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.84E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	2.03E-02	6.74E-02	**8.90E+00**	6.27E-01	2.22E-01	6.27E-01
Uranium	3.07E-08	1.13E-07	6.25E-06	3.07E-07	2.81E-06	3.07E-07	3.43E-05	1.26E-04	7.00E-03	3.43E-04	3.15E-03	3.43E-04
Background Exposure												
Aluminum	1.14E-02	4.45E-02	6.53E-01	6.35E-02	8.04E-01	6.35E-02	1.13E-02	4.40E-02	6.47E-01	6.29E-02	7.96E-01	6.29E-02
Copper	7.89E-02	5.36E-01	**1.50E+00**	7.50E-01	**1.50E+00**	7.50E-01	1.11E-01	7.50E-01	**2.10E+00**	**1.05E+00**	**2.10E+00**	**1.05E+00**
Lead	6.83E-03	2.27E-02	**3.00E+00**	2.11E-01	7.50E-02	2.11E-01	1.82E-02	6.06E-02	**8.00E+00**	5.63E-01	2.00E-01	5.63E-01
Uranium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E-05	4.00E-05	2.22E-03	1.09E-04	1.00E-03	1.09E-04

Notes:

Bold – value exceeds the Screening Index (SI) benchmark value of 1.

(grey shading) <25% due to incremental exposure from the Project; >75% due to background exposure

(orange shading) >25% due to incremental exposure from the Project; this pertains to scenarios that expose the waste to the environment with no containment (i.e., waste directly in the swamp) and are deliberately extreme scenarios and highly unlikely to occur.

(1) 'What-If' cases make deliberately extreme assumptions so as to understand the limits of safety performance and are not compared with any criteria because they are extremely unlikely, and in some cases implausible. Screening index (SI) values for 'What-If' cases are only provided for perspective.

Table 5-6 Non-Radiological Risk Screening Index Results for Aquatic Birds

Post-closure Scenario & COPC	Ottawa River (Receptor 1)			Perch Creek (Receptor 2)		
	Great Blue Heron	Mallard	Belted Kingfisher	Great Blue Heron	Mallard	Belted Kingfisher
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.83E-02	1.99E-01	1.51E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.92E-05	7.89E-04	2.09E-04
(1a) NES Sensitivity Analysis: Inventory Sensitivity						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.83E-02	1.99E-01	1.51E-01
Uranium	1.01E-04	2.95E-04	2.03E-04	1.36E-04	1.31E-03	2.60E-04
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.83E-02	1.99E-01	1.51E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.92E-05	7.89E-04	2.09E-04
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.98E-02	2.07E-01	1.57E-01
Uranium	1.01E-04	2.95E-04	2.03E-04	1.47E-04	1.49E-03	2.74E-04
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.84E-02	1.99E-01	1.51E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.99E-05	8.03E-04	2.10E-04
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.04E-03
Lead	1.27E-02	7.22E-02	5.14E-02	3.73E-02	1.93E-01	1.47E-01
Uranium	9.95E-05	2.85E-04	2.03E-04	9.91E-05	7.81E-04	2.10E-04
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.80E-02	1.97E-01	1.50E-01
Uranium	9.96E-05	2.86E-04	2.03E-04	9.69E-05	7.44E-04	2.06E-04
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.83E-02	1.99E-01	1.51E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.92E-05	7.89E-04	2.09E-04
(4) Disruptive Event: Enhanced Corrosion Case [1]						
Aluminum	1.32E-01	7.49E-01	6.41E-02	1.54E-01	8.75E-01	7.47E-02
Lead	1.30E-02	7.86E-02	5.14E-02	4.58E-02	2.45E-01	1.82E-01
Uranium	9.93E-05	2.83E-04	2.03E-04	1.05E-04	9.01E-04	2.16E-04
(5) Disruptive Event: Localized Cover Failure						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.83E-02	1.99E-01	1.51E-01
Uranium	9.96E-05	2.86E-04	2.03E-04	9.90E-05	7.87E-04	2.09E-04
(6) Disruptive Event: Localized Liner Failure						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Uranium	9.95E-05	2.85E-04	2.03E-04	1.06E-04	8.87E-04	2.19E-04

Post-closure Scenario & COPC	Ottawa River (Receptor 1)			Perch Creek (Receptor 2)		
	Great Blue Heron	Mallard	Belted Kingfisher	Great Blue Heron	Mallard	Belted Kingfisher
(7) Disruptive Event: Damage to Berm						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.24E-02	5.14E-02	3.85E-02	2.00E-01	1.52E-01
Uranium	9.99E-05	2.88E-04	2.03E-04	9.77E-05	7.69E-04	2.06E-04
(9) Dose Optimization: Wastes Grouted into Steel Liners						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.23E-02	5.14E-02	3.83E-02	1.99E-01	1.51E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.68E-05	7.54E-04	2.05E-04
(11) Defence-in-Depth: Role of Geosphere						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.24E-02	5.14E-02	4.02E-02	2.09E-01	1.59E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	1.02E-04	8.16E-04	2.13E-04
(12) Defence-in-Depth: Role of Cover						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.24E-02	5.14E-02	3.84E-02	2.00E-01	1.52E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.95E-05	7.94E-04	2.09E-04
(13) Defence-in-Depth: Role of Base Liner						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.04E-03
Lead	1.27E-02	7.10E-02	5.14E-02	3.76E-02	1.94E-01	1.49E-01
(14) Defence-in-Depth: Series of Landslides [1]						
Aluminum	4.03E-01	**2.28E+00**	1.93E-01	**2.06E+02**	**1.17E+03**	**9.88E+01**
Copper	8.46E-02	2.14E-01	6.58E-03	1.69E-01	**1.23E+00**	3.69E-01
Lead	1.31E-02	8.10E-02	5.16E-02	7.91E-02	4.30E-01	3.23E-01
Uranium	1.01E-04	2.94E-04	2.03E-04	1.43E-04	1.77E-03	2.35E-04
(15) “What-If”: Human Intrusion, Mass Excavation and Farming [2]						
Copper	1.97E-02	6.44E-02	6.05E-03	1.96E-02	6.72E-02	8.04E-03
Uranium	1.01E-04	2.96E-04	2.03E-04	1.34E-04	1.29E-03	2.59E-04
(17) “What-If”: Permanent Bathtub [2]						
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.05E-03
Lead	1.27E-02	7.24E-02	5.14E-02	4.02E-02	2.09E-01	1.59E-01
Uranium	9.97E-05	2.86E-04	2.03E-04	9.19E-05	6.97E-04	1.95E-04
Background Exposure						
Aluminum	1.39E-01	7.62E-01	6.40E-02	1.38E-01	7.55E-01	6.34E-02
Copper	4.07E-03	2.87E-02	6.05E-03	3.95E-03	3.15E-02	8.04E-03
Lead	1.27E-02	7.10E-02	5.14E-02	3.66E-02	1.89E-01	1.44E-01
Uranium	9.87E-05	2.78E-04	2.03E-04	7.73E-05	3.56E-04	1.61E-04

Notes:

Bold – value exceeds the Screening Index (SI) benchmark value of 1.

(grey) <25% due to incremental exposure from the Project; >75% due to background exposure

(orange) >25% due to incremental exposure from the Project; this pertains to scenarios that expose the waste to the environment with no containment (i.e., waste directly in the swamp) and are deliberately extreme scenarios and highly unlikely to occur.

(1) For scenarios (4) and (14), incremental aluminum concentrations were not predicted in soil in either the Grazing Area or the Garden Area. Thus, exposure from terrestrial pathways is not considered in the assessment for the great blue heron, which is assumed to consume small mammals from the Grazing Area, and the mallard, which is assumed to consume terrestrial vegetation and invertebrates/insects from the Grazing Area.

(2) ‘What-If’ cases make deliberately extreme assumptions so as to understand the limits of safety performance and are not compared with any criteria because they are extremely unlikely, and in some cases implausible. Screening index (SI) values for ‘What-If’ cases are only provided for perspective.

Table 5-7 Non-Radiological Risk Screening Index Results for Terrestrial Based Receptors (small home range)

Post-closure Scenario & COPC	Grazing Area (Receptor 1)							Garden Area (Receptor 2)						
	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.76E-03	5.06E-03	1.51E-03	9.44E-03	1.84E-03	7.00E-03	7.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(1a) NES Sensitivity Analysis: Inventory Sensitivity														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	1.25E-02	8.17E-03	2.44E-03	1.52E-02	2.97E-03	1.20E-02	1.20E-02	3.15E-03	2.06E-03	6.15E-04	3.84E-03	7.55E-04	3.00E-03	3.00E-03
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.76E-03	5.06E-03	1.51E-03	9.44E-03	1.84E-03	1.20E-02	1.20E-02	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	1.25E-02	8.17E-03	2.44E-03	1.52E-02	2.97E-03	1.20E-02	1.20E-02	3.15E-03	2.06E-03	6.15E-04	3.84E-03	7.57E-04	3.00E-03	3.00E-03
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	**9.63E-02**	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.76E-03	5.06E-03	1.51E-03	9.44E-03	1.84E-03	1.20E-02	1.20E-02	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**3.92E+00**	1.19E-01	1.11E-01	1.92E-01	1.04E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.08E-03	4.62E-03	1.38E-03	8.61E-03	1.68E-03	1.20E-02	1.20E-02	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**3.99E+00**	1.21E-01	1.13E-01	1.96E-01	1.06E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.53E-03	4.92E-03	1.47E-03	9.17E-03	1.79E-03	1.20E-02	1.20E-02	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.76E-03	5.06E-03	1.51E-03	9.44E-03	1.84E-03	1.20E-02	1.20E-02	3.57E-03	2.33E-03	6.97E-04	4.35E-03	8.50E-04	3.00E-03	3.00E-03
(4) Disruptive Event: Enhanced Corrosion Case [1]														
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	**1.05E+01**	**1.26E+01**	**2.61E+00**	**1.17E+01**	**1.13E+01**	**1.28E+01**	**1.28E+01**	NA	NA	NA	NA	NA	NA	NA
Lead	**7.99E+00**	2.42E-01	2.27E-01	3.92E-01	2.12E-01	5.23E-01	5.23E-01	NA	NA	NA	NA	NA	NA	NA
Uranium	6.14E-03	4.01E-03	1.20E-03	7.48E-03	1.46E-03	5.86E-03	5.86E-03	NA	NA	NA	NA	NA	NA	NA
(5) Disruptive Event: Localized Cover Failure														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.69E-03	5.02E-03	1.50E-03	9.36E-03	1.82E-03	7.00E-03	7.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(6) Disruptive Event: Localized Liner Failure														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**3.92E+00**	1.19E-01	1.11E-01	1.93E-01	1.04E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	Uranium	7.18E-03	4.69E-03	1.40E-03	8.74E-03	1.70E-03	7.00E-03	7.00E-03	3.15E-03	2.06E-03	6.14E-04	3.83E-03	7.51E-04	3.00E-03

Post-closure Scenario & COPC	Grazing Area (Receptor 1)							Garden Area (Receptor 2)						
	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation	Canada Warbler *	Purple Finch	Ruffed Grouse	Short-tailed Shrew	Meadow Vole	Earthworm (soil)	Terrestrial Vegetation
(7) Disruptive Event: Damage to Berm														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.07E+00**	1.23E-01	1.15E-01	2.00E-01	1.08E-01	2.70E-01	2.70E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	8.66E-03	5.65E-03	1.69E-03	1.05E-02	2.05E-03	8.00E-03	8.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(8) Dose Optimization: Wastes Grouted into Steel Liners														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.76E-03	5.07E-03	1.51E-03	9.45E-03	1.84E-03	7.00E-03	7.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(11) Defence-in-Depth: Role of Geosphere														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.03E+00**	1.22E-01	1.14E-01	1.98E-01	1.07E-01	2.60E-01	2.60E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.76E-03	5.06E-03	1.51E-03	9.44E-03	1.84E-03	7.00E-03	7.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(12) Defence-in-Depth: Role of Cover														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.06E+00**	1.23E-01	1.15E-01	1.99E-01	1.08E-01	2.70E-01	2.70E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.92E-03	5.17E-03	1.55E-03	9.64E-03	1.88E-03	8.00E-03	8.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.50E-04	3.00E-03	3.00E-03
(13) Defence-in-Depth: Role of Base Liner														
Copper	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
(14) Defence-in-Depth: Series of Landslides [1]														
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	**3.28E+01**	**3.95E+01**	**8.17E+00**	**3.67E+01**	**3.52E+01**	**4.01E+01**	**4.01E+01**	NA	NA	NA	NA	NA	NA	NA
Lead	**9.33E+00**	2.83E-01	2.65E-01	4.58E-01	2.48E-01	6.10E-01	6.10E-01	NA	NA	NA	NA	NA	NA	NA
Uranium	1.17E-02	7.63E-03	2.28E-03	1.42E-02	2.78E-03	1.10E-02	1.10E-02	NA	NA	NA	NA	NA	NA	NA
(15) “What-If”: Human Intrusion, Mass Excavation and Farming [2]														
Copper	**6.49E+00**	**7.80E+00**	**1.61E+00**	**7.26E+00**	**6.96E+00**	**7.93E+00**	**7.93E+00**	**6.96E+00**	**8.36E+00**	**1.73E+00**	**7.79E+00**	**7.46E+00**	**8.50E+00**	**8.50E+00**
Lead	**6.29E+00**	1.91E-01	1.79E-01	3.09E-01	1.67E-01	4.10E-01	4.10E-01	**6.78E+00**	2.05E-01	1.92E-01	3.33E-01	1.80E-01	4.40E-01	4.40E-01
Uranium	1.31E-02	8.58E-03	2.57E-03	1.60E-02	3.12E-03	1.30E-02	1.30E-02	1.00E-02	6.53E-03	1.95E-03	1.22E-02	2.37E-03	1.00E-02	1.00E-02
(17) “What-If”: Permanent Bathtub [2]														
Copper	1.29E-01	1.55E-01	3.21E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**4.07E+00**	1.23E-01	1.15E-01	1.99E-01	1.08E-01	2.70E-01	2.70E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	7.92E-03	5.17E-03	1.54E-03	9.64E-03	1.88E-03	8.00E-03	8.00E-03	3.15E-03	2.05E-03	6.14E-04	3.83E-03	7.49E-04	3.00E-03	3.00E-03
Background Exposure														
Aluminum	**9.38E+00**	**5.44E+00**	**1.73E+00**	**2.52E+01**	**4.11E+00**	**6.00E+02**	**6.00E+02**	**9.38E+00**	**5.44E+00**	**1.73E+00**	**2.52E+01**	**4.11E+00**	**6.00E+02**	**6.00E+02**
Copper	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01	1.29E-01	1.55E-01	3.20E-02	1.44E-01	1.38E-01	1.60E-01	1.60E-01
Lead	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01	**3.18E+00**	9.63E-02	9.01E-02	1.56E-01	8.43E-02	2.10E-01	2.10E-01
Uranium	3.14E-03	2.05E-03	6.14E-04	3.83E-03	7.45E-04	0.00E+00	0.00E+00	3.14E-03	2.05E-03	6.14E-04	3.83E-03	7.45E-04	0.00E+00	0.00E+00

Notes:

Bold – value exceeds the Screening Index (SI) benchmark value of 1.

(grey shading) <25% due to incremental exposure from the Project; >75% due to background exposure

(orange shading) >25% due to incremental exposure from the Project: this pertains to scenarios that expose the waste to the environment with no containment (i.e., waste directly in the swamp) and are deliberately extreme scenarios, highly unlikely to occur.

* Species at Risk

NA – Not Assessed

(1) For scenarios (4) and (14), aluminum concentrations were not predicted in soil for the Grazing Area and Garden Area and copper, lead and uranium concentrations were not predicted for the Garden Area. Thus, exposure through terrestrial pathways could not be assessed.

(2) ‘What-If’ cases make deliberately extreme assumptions so as to understand the limits of safety performance and are not compared with any criteria because they are extremely unlikely, and in some cases implausible. Screening index (SI) values for ‘What-If’ cases are only provided for perspective.

Table 5-8 Non-Radiological Risk Screening Index Results for Sitewide Receptors (large home range)

Post-closure Scenario & COPC	Sitewide						
	Bald Eagle	Black Bear	Little Brown Myotis *	Eastern Whip-poor-will *	Eastern Wolf *	Moose	White-tailed Deer
(1) Normal Evolution Scenario (NES) and (9) Dose Optimization: Confidence in Land Use Restrictions							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.30E-02	2.76E-02	9.64E-02	**1.20E+00**	7.18E-03	4.92E-02	2.85E-02
Uranium	2.32E-04	5.90E-04	1.99E-03	3.99E-04	5.42E-04	3.40E-04	3.17E-04
(1a) NES Sensitivity Analysis: Inventory Sensitivity							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.30E-02	2.76E-02	9.64E-02	**1.20E+00**	7.18E-03	4.92E-02	2.85E-02
Uranium	3.33E-04	8.47E-04	2.44E-03	5.74E-04	7.79E-04	4.89E-04	4.73E-04
(1b) NES Sensitivity Analysis: Institutional Control							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.30E-02	2.76E-02	9.64E-02	**1.20E+00**	7.18E-03	4.92E-02	2.85E-02
Uranium	2.32E-04	5.90E-04	1.99E-03	3.99E-04	5.42E-04	3.40E-04	3.17E-04
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.35E-02	2.76E-02	9.67E-02	**1.20E+00**	7.19E-03	4.99E-02	2.85E-02
Uranium	3.34E-04	8.48E-04	2.47E-03	5.74E-04	7.79E-04	4.89E-04	5.13E-04
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.31E-02	2.76E-02	9.64E-02	**1.20E+00**	7.18E-03	4.92E-02	2.85E-02
Uranium	2.32E-04	5.90E-04	1.99E-03	3.99E-04	5.42E-04	3.40E-04	3.20E-04
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner							
Copper	4.80E-03	3.71E-02	5.57E-01	5.03E-02	1.96E-02	7.62E-02	4.16E-02
Lead	2.26E-02	2.72E-02	9.50E-02	**1.18E+00**	7.07E-03	4.83E-02	2.80E-02
Uranium	2.18E-04	5.53E-04	1.94E-03	3.74E-04	5.09E-04	3.19E-04	3.10E-04
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER							
Copper	4.80E-03	3.71E-02	5.57E-01	5.03E-02	1.96E-02	7.62E-02	4.16E-02
Lead	2.29E-02	2.75E-02	9.59E-02	**1.20E+00**	7.14E-03	4.89E-02	2.83E-02
Uranium	2.27E-04	5.78E-04	1.96E-03	3.91E-04	5.31E-04	3.33E-04	3.04E-04
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.30E-02	2.76E-02	9.64E-02	**1.20E+00**	7.18E-03	4.92E-02	2.85E-02
Uranium	2.41E-04	6.13E-04	2.02E-03	4.15E-04	5.63E-04	3.54E-04	3.20E-04
(4) Disruptive Event: Enhanced Erosion Case [1]							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Copper	1.79E-01	**2.99E+00**	**8.09E+00**	**4.10E+00**	**1.59E+00**	**3.39E+00**	**3.68E+00**
Lead	3.57E-02	6.04E-02	2.02E-01	**2.67E+00**	1.59E-02	6.31E-02	8.63E-02
Uranium	1.32E-04	3.33E-04	1.66E-03	2.25E-04	3.06E-04	1.92E-04	3.03E-04
(5) Disruptive Event: Localized Cover Failure							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.31E-02	2.76E-02	9.65E-02	**1.20E+00**	7.19E-03	4.92E-02	2.85E-02
Uranium	2.30E-04	5.86E-04	1.98E-03	3.97E-04	5.39E-04	3.38E-04	3.16E-04
(6) Disruptive Event: Localized Liner Failure							
Copper	4.80E-03	3.71E-02	5.57E-01	5.03E-02	1.96E-02	7.62E-02	4.16E-02
Lead	2.28E-02	2.72E-02	9.52E-02	**1.18E+00**	7.08E-03	4.86E-02	2.81E-02
Uranium	2.20E-04	5.59E-04	1.97E-03	3.78E-04	5.14E-04	3.23E-04	3.34E-04
(7) Disruptive Event: Damage to Berm							
Copper	4.81E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.32E-02	2.78E-02	9.69E-02	**1.21E+00**	7.22E-03	4.95E-02	2.86E-02
Uranium	2.51E-04	6.39E-04	2.04E-03	4.32E-04	5.87E-04	3.68E-04	3.19E-04
(8) Dose Optimization: Wastes Grouted into Steel Liners							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.30E-02	2.76E-02	9.64E-02	**1.20E+00**	7.18E-03	4.92E-02	2.85E-02
Uranium	2.32E-04	5.90E-04	1.98E-03	3.99E-04	5.43E-04	3.40E-04	3.09E-04
(11) Defence-in-Depth: Role of Geosphere							
Copper	4.81E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.37E-02	2.77E-02	9.66E-02	**1.20E+00**	7.19E-03	5.01E-02	2.85E-02
Uranium	2.32E-04	5.90E-04	2.00E-03	3.99E-04	5.42E-04	3.40E-04	3.23E-04
(12) Defence-in-Depth: Role of Cover							
Copper	4.80E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.31E-02	2.77E-02	9.68E-02	**1.21E+00**	7.21E-03	4.94E-02	2.86E-02
Uranium	2.35E-04	5.99E-04	2.00E-03	4.05E-04	5.50E-04	3.45E-04	3.19E-04
(13) Defence-in-Depth: Role of Base Liner							
Copper	4.80E-03	3.71E-02	5.57E-01	5.02E-02	1.96E-02	7.62E-02	4.15E-02
Lead	2.18E-02	2.44E-02	8.62E-02	**1.06E+00**	6.34E-03	4.56E-02	2.51E-02
(14) Defence-in-Depth: Series of Landslides [1]							
Aluminum	NA	NA	NA	NA	NA	NA	NA
Copper	5.89E-01	**9.34E+00**	**2.43E+01**	**1.28E+01**	**4.98E+00**	**1.06E+01**	**1.18E+01**
Lead	4.99E-02	7.10E-02	2.34E-01	**3.11E+00**	1.86E-02	7.37E-02	1.12E-01
Uranium	2.51E-04	6.34E-04	2.37E-03	4.29E-04	5.83E-04	3.66E-04	5.39E-04
(15) "What-If": Human Intrusion, Mass Excavation and Farming [2]							
Copper	1.07E-01	**1.91E+00**	**5.34E+00**	**2.62E+00**	**1.02E+00**	**2.17E+00**	**2.26E+00**
Lead	3.16E-02	4.96E-02	1.67E-01	**2.18E+00**	1.30E-02	5.16E-02	7.41E-02
Uranium	4.92E-04	1.25E-03	2.97E-03	8.47E-04	1.15E-03	7.22E-04	5.29E-04
(17) "What-If": Permanent Bathtub [2]							
Copper	4.81E-03	3.72E-02	5.57E-01	5.03E-02	1.96E-02	7.63E-02	4.16E-02
Lead	2.37E-02	2.78E-02	9.70E-02	**1.21E+00**	7.22E-03	5.02E-02	2.86E-02
Uranium	2.35E-04	5.99E-04	1.96E-03	4.05E-04	5.50E-04	3.45E-04	2.96E-04

Post-closure Scenario & COPC	Sitewide						
	Bald Eagle	Black Bear	Little Brown Myotis *	Eastern Whip-poor-will *	Eastern Wolf *	Moose	White-tailed Deer
Background Exposure							
Aluminum	4.03E-01	**2.03E+00**	**1.46E+02**	7.92E-01	**1.90E+01**	2.54E-01	**1.06E+00**
Copper	4.80E-03	3.71E-02	5.57E-01	5.02E-02	1.96E-02	7.62E-02	4.15E-02
Lead	2.15E-02	2.44E-02	8.61E-02	**1.06E+00**	6.34E-03	4.52E-02	2.51E-02
Uranium	1.33E-04	3.40E-04	1.55E-03	2.30E-04	3.13E-04	1.96E-04	1.67E-04

Notes:
Bold – value exceeds the Screening Index (SI) benchmark value of 1.
[grey] <25% due to incremental exposure from the Project; >75% due to background exposure
[orange] >25% due to incremental exposure from the Project; this pertains to scenarios that expose the waste to the environment with no containment (i.e., waste directly in the swamp) and are deliberately extreme scenarios, highly unlikely to occur.
* Species at Risk
(1) For scenarios (4) and (14), aluminum concentrations were not predicted in soil for the Grazing Area and Garden Area and thus exposure through terrestrial pathways could not be assessed. In addition, copper, lead and uranium concentrations were not predicted for the Garden Area and thus for these COPC the site-wide receptors were assumed to obtain 100% of their exposure through soil consumption from soil from the Grazing Area.
(2) 'What-If' cases make deliberately extreme assumptions so as to understand the limits of safety performance and are not compared with any criteria because they are extremely unlikely, and in some cases implausible. Screening index (SI) values for 'What-If' cases are only provided for perspective.

5.2 Discussion of Risk Results

5.2.1 Exposure to Radiological COPCs

As seen from Table 5-1 to Table 5-4, for all post-closure scenarios, there were no exceedances of the SI benchmark value of 1 for any of the ecological receptors that were assessed, including species at risk, regardless of the exposure location (i.e., Ottawa River, Perch Creek, Grazing Area, Garden Area, Sitewide). All of the SI values were well below the benchmark value of 1 with the highest SI value being 0.443 (for the SARA species little brown myotis in scenario (15) What-If – Human Intrusion, Mass Excavation and Farming, which is a rather extreme circumstance). Furthermore, these results have a large safety margin given the very conservative assumptions that were used in the EcoRA. For example, all of the ecological receptors were assumed to spend all of their time on-site, consuming all of their food and water from their local exposure area regardless of their migratory patterns or home ranges. Another conservative assumption was the use of maximum radionuclide concentrations.

5.2.2 Exposure to Non-radiological COPCs

With respect to non-radiological COPCs, aluminum was only assessed for scenario (4) Disruptive Event – Enhanced Erosion Case and scenario (14) Disruptive Event – Series of Landslides, and only for aquatic pathways as meaningful aluminum concentrations in soil were not predicted for these scenarios. Copper, lead and uranium (except scenario 13) were assessed for all scenarios, although not for the Garden Area in scenarios (4) and (14) as soil concentrations were not predicted for these COPCs. The assessment results (SI values) are presented in Table 5-5 to Table 5-8, where the background contribution is included at the bottom of each table. Also, where an SI value exceeds the threshold value of 1, the SI value is presented in bold and highlighted in grey if the background contribution to the exposure is >75% and in orange if the incremental contribution from the NSDF Project is >25%.

As seen from Table 5-5 to Table 5-8, no potential issues are identified from exposure to uranium for all scenarios, receptors and locations as all SI values are below the threshold value of 1. Also, with the exception of scenario (14), there are no issues identified for aquatic birds – great blue heron, mallard, belted kingfisher – in Ottawa River or Perch Creek resulting from exposure to copper, lead or uranium (Table 5-6). In scenario (14), potential effects are identified for all three birds in Perch Creek and for mallard in the Ottawa River due to aluminum as well as for mallard resulting from copper exposure in Perch Creek. The SI values are as high as 1170 for mallard exposed to aluminum in Perch Creek. While exposures in this scenario are being driven by NSDF Project emissions (>95% in Perch Creek), it is noted that this scenario represents an extreme circumstance that is highly unlikely to occur.

Table 5-5 summarizes the SI results for aquatic biota (aquatic vegetation, benthic and pelagic fish, benthic invertebrates, zooplankton and tadpole) in the Ottawa River and Perch Creek. As seen from the table, the SI threshold is exceeded for copper exposure to benthic invertebrates, pelagic fish (Perch Creek only), zooplankton and tadpole (Perch Creek only) and lead exposure to benthic invertebrates for all scenarios. With the exception of scenarios (4) and (14), these exposures are completely dominated by background levels. In scenario (4), all aquatic organisms in Perch Creek are potentially affected by exposure to copper mainly due to releases from the NSDF Project (about 90%). In scenario (14) all organisms in Perch Creek are potentially affected by exposure to aluminum and copper as well as lead for benthic invertebrates, pelagic fish and tadpole, predominantly driven by releases from the NSDF Project; in the Ottawa River, benthic invertebrates and zooplankton are potentially affected by aluminum releases from the NSDF Project. SI values are as high as 1020 for benthic invertebrates in Perch Creek resulting from aluminum exposure. Scenario (4) simulating a Disruptive Event and scenario (14) simulating a Defence-in-Depth case both represent extreme circumstances that are highly unlikely to occur.

The SI results for terrestrial receptors with small home ranges located either in the Grazing Area or Garden Area on the ECM are summarized in Table 5-7. Receptors included in this category are Canada warbler (species at risk), purple finch, ruffed grouse, short-tailed shrew, meadow vole, earthworm and terrestrial vegetation. With the exception of scenario (4), scenario (14) and scenario (15) What-if – Human Intrusion, Mass Excavation and Farming, exposure to lead dominated by background levels resulted in SI values above 1 for the Canada warbler in all scenarios for both the Grazing Area and Garden Area. Exposure to copper dominated by releases from the NSDF Project resulted in SI values greater than 1 for all receptors in the Grazing Area and Garden Area (scenario (15) only) in scenarios (4), (14) and (15). This was also the case for lead exposure to Canada warbler. Again, it is noted that scenarios (4) and (14), as well as scenario (15) simulating a 'What-if' case, all represent extreme circumstances that are highly unlikely to occur.

Sitewide receptors are assumed to roam the entire site while being exposed to COPCs in all aquatic and terrestrial assessment areas – Ottawa River, Perch Creek, Grazing Area and Garden Area. Sitewide receptors include the bald eagle, black bear, little brown myotis (bat) (species at risk), eastern whip-poor-will (species at risk), eastern wolf (species at risk), moose and white-tailed deer. The SI results for sitewide receptors are summarized in Table 5-8. With the exception of scenarios (4), (14) and (15), the lead SI value for eastern-whip-poor-will exceeded the threshold value of 1 in all scenarios resulting predominantly from background exposure. Estimated exposures in scenarios (4), (14) and (15) are again dominated by NSDF Project releases with copper exposure to all organisms except the bald eagle resulting in SI values above 1; this is also the case for lead exposure to eastern whip-poor-will.

Potential effects from exposure to copper and lead are identified for many aquatic and terrestrial receptors in all scenarios but with the exception of scenarios (4), (14) and (15), these exposures are completely dominated by background levels in environmental media. Potential effects from exposure to aluminum, copper and lead driven by NSDF Project releases are identified for many aquatic and terrestrial receptors in scenarios (4), (14) and (15). Scenario (4) simulates the effects of enhanced erosion, scenario (14) the effects of a series of landslides and scenario (15) the effects of mass excavation of the area. All of these scenarios are deliberately extreme with waste exposed to the environment with no containment (i.e., waste directly in the swamp) and are highly unlikely to occur.

Much of the lead at NSDF will be embedded in structural steel (and thus would likely not be released until the steel is corroded), and otherwise treated to meet land disposal requirements of Ontario Regulation

347. These processes have not been accounted for in this study. If these processes were accounted for, they could further delay releases and potentially also reduce the peak flux of lead.

Finally, it is noted that conventional landfills can contain significant quantities of lead. The engineering design for the ECM is consistent with best practice for a conventional landfill, and in the context of containment of lead, will provide similar long-term performance to a contemporary conventional landfill.

5.2.3 Common (Northern) Watersnake

The northern watersnake *(Nerodia sipedon sipdeon)* and the Lake Erie *(Nerodia sipedon insularum)* watersnake are both subspecies of the common watersnake *(Nerodia sipedon).* The Lake Erie watersnake is found only on islands in western Lake Erie and on its southern shore in Ohio. The northern watersnake is found throughout southern Ontario, as far north as Sudbury. It is widespread and abundant within its range in Canada and one of the most commonly seen snakes around lakes (Ontario Nature 2018).

The northern watersnake can be found in and around almost any permanent body of fresh water within its range, including lakes, rivers and wetlands. These snakes can be found in shoreline habitats along the edges of the water or under rocks along the shoreline. Northern watersnakes hibernate underground in dens or crevices, or in beaver lodges. They breed in the spring following hibernation. The northern watersnake eats fish and amphibians, which are hunted along the water's edge or underwater. It is an excellent swimmer and can be found up to three meters below the water surface and several kilometres from shore. It is frequently seen basking in the open, often in large groups. The species is active in the day and at night (Ontario Nature 2018).

A lack of appropriate information on snake characteristics precluded the quantitative assessment of risks to the common watersnake from radiation exposure. As an aquatic based reptile, it would receive most of its exposure from water and sediment. While the risks to the common watersnake could not be quantified, it is noted from Table 5-2 that the SI values for radiation dose that were calculated for other semi-aquatic reptile species, such as the snapping turtle, were very low, less than 10^{-5}, suggesting that radiation exposure during the post-closure phase of the NSDF Project would not likely result in residual effects to the common watersnake. Non-radiological risks were not quantified for the snapping turtle due to a lack of information, and therefore a similar comparison cannot be made for the watersnake.

5.2.4 Species at Risk

Brief discussions of each species at risk included in the EcoRA are provided in the following sections.

5.2.4.1 Canada Warbler

The Canada warbler *(Cardellina canadensis)* is a small, brightly coloured songbird with threatened status under SARA. The Canada warbler only breeds in North America and 80% of its known breeding range is in Canadian territory extending from the southernmost parts of Yukon and Northwest Territories to the Great Lakes region. The densest populations are in the eastern provinces of Ontario, Quebec and the Maritimes. It breeds in a range of deciduous and coniferous, usually wet forest types, all with a well-developed, dense shrub layer. Dense shrub and understory vegetation help conceal Canada warbler nests that are usually located on or near the ground on mossy logs or roots, along stream banks or on hummocks. The Canada warbler winters in South America. The Canada warbler is primarily an insectivore, feeding on flying insects such as mosquitoes, butterflies, and moths, as well as spiders (MNRF 2018b; Nature Canada 2018a).

The results of the EcoRA did not indicate any residual effects on the Canada warbler from exposure to radiation during the post-closure phase of the NSDF Project, with the highest SI being 0.11 in scenario (15) What-If – Human Intrusion, Mass Excavation and Farming (Table 5-3).

With respect to non-radiological exposure, potential residual effects were predicted for the Canada warbler from exposure to copper and lead in the Grazing Area and Garden Area with the main pathways of exposure being earthworm and soil ingestion. For most scenarios, these exposures were dominated by background contaminant levels in soil but for scenarios (4), (14) and (15), releases from the NSDF Project during the post-closure phase contributed significantly to the exposure; however, these scenarios represent extreme circumstances that are highly unlikely to occur.

5.2.4.2 Eastern Milksnake

The Eastern Milksnake (*Lampropeltis triangulum*) is a reptile with special concern status under SARA. Milksnakes are found in southern Canada and in Ontario they can be found as far north as Lake Nipissing and Sault St. Marie. The Milksnake is best known for occurring in rural areas, where it is most frequently reported in and around buildings (Government of Canada 2016a).

Milksnakes are diurnal (active at dawn and dusk) in the spring and fall but become largely nocturnal (active at night) in the summer. These snakes are very secretive, spending much of their time hiding beneath logs, rocks, boards, bark and other debris. In Canada, Milksnakes go into hibernation in late October to early November and emerge from their hibernacula in April or May when mating occurs. Suitable hibernation sites will have enough moisture to prevent them from drying out over the winter and include mammal burrows, hollow logs, gravel or dirt banks, old wells, or old building foundations. The two greatest causes of Milksnake population decline are likely road mortality and deliberate killing by humans. They are also affected by habitat loss and modification due to urbanization, as well as predation (Government of Canada 2016a).

A lack of appropriate information on snake characteristics precluded the quantitative assessment of risks to the milksnake from radiation exposure. As a terrestrial based reptile, it would receive most of its exposure from soil. While the risks to the milksnake could not be quantified, it is noted from Table 5-3 that the SI values that were calculated for other burrowing species (e.g., earthworm, short tailed shrew) were low (< 0.01), suggesting that radiation exposure during the post-closure phase of the NSDF Project would not likely result in residual effects to the milksnake. However, with respect to non-radiological exposure, potential residual effects were identified for the shrew and earthworm resulting from exposure to copper in the Grazing Area and Garden Area that could signify potential risks to the milksnake. It is noted however, that while these exposures were driven by releases from the NSDF Project, they were only noted for scenarios (4), (14) and (15) which represent extreme circumstances and are highly unlikely to occur.

5.2.4.3 Eastern Whip-poor-will

In Canada the eastern whip-poor-will *(Antrostomus vociferus)* can be found from east-central Saskatchewan to central Nova Scotia and in Ontario they breed as far north as the shore of Lake Superior. The eastern whip-poor-will has threatened status under SARA (MNRF 2018c; Nature Canada 2018b).

The eastern whip-poor-will is a medium sized bird 22 or 26 cm long with mottled brown and grey feathers that help it blend in with its surroundings. Since it becomes active at dusk and rests during the day, it is more commonly heard than seen. It is usually found in areas with a mix of open and forested areas such as savannahs, open woodlands or openings in more mature, deciduous, coniferous and mixed forests. It forages in these open areas and uses forested areas for roosting (resting and sleeping) and nesting (MNRF 2018c). This bird forages at night, especially at dusk and dawn and on moonlit nights. It feeds on flying insects, especially moths, also beetles, mosquitoes, and many others (National Audubon Society 2018).

The results of the EcoRA did not indicate any residual effects on the eastern whip-poor-will from exposure to radiation during the post-closure phase of the NSDF Project, with the highest SI being 0.14 in scenario (1a) NES SA - Inventory Sensitivity Case (Table 5-4).

With respect to non-radiological exposure, potential residual effects were predicted for the eastern-whip-poor-will from exposure to copper and lead. For most scenarios, these exposures were dominated by background contaminant levels in soil but for scenarios (4), (14) and (15), releases from the NSDF Project during the post-closure phase contributed significantly to the exposure; however, these scenarios represent extreme circumstances that are highly unlikely to occur.

5.2.4.4 Eastern Wolf

The Eastern Wolf (*Canis lycaon*) is smaller than other wolves and is found primarily in the forests of the Great Lakes and St. Lawrence regions of Ontario and Quebec where it preys on White-tailed Deer and Moose. Eastern Wolves live in family-based packs composed of a breeding pair and offspring from the current and previous years. Due to loss of habitat, hunting and trapping, it is listed as a species of special concern under SARA (Government of Canada 2016b).

The results of the EcoRA did not indicate any residual effects on the eastern wolf from exposure to radiation during the post-closure phase of the NSDF Project, with the highest SI being 0.11 in scenario (1a) NES SA - Inventory Sensitivity Case (Table 5-4).

With respect to non-radiological exposure, potential residual effects were predicted for the eastern wolf from exposure to copper. For most scenarios, these exposures were dominated by background contaminant levels in soil but for scenarios (4), (14) and (15), releases from the NSDF Project during the post-closure phase contributed significantly to the exposure; however, these scenarios represent extreme circumstances that are highly unlikely to occur.

5.2.4.5 Little Brown Myotis

The little brown myotis (*Myotis lucifugus*) is likely the most common and widespread of Canada's nineteen species of bat and is protected under SARA as it is an endangered species. The little brown myotis is one of the smaller Canadian bats, weighing only seven to fourteen grams and having a wingspan of 22-27 cm (CWF 2016). This and other small-bodied bat species that winter in caves or mines are dying from White-nose Syndrome (WNS), caused by the fungus *Pseudogymnoascus destructans* (*Pd*), (formerly known as *Geomyces destructan*) (Environment Canada 2015).

The little brown myotis plays an important role as a predator of night flying insects. It is a are very efficient hunter capable of catching over 1000 insects in just one hour. It concentrates on insects that have an aquatic larval stage, such as mosquitoes, midges, and mayflies. Consequently, they prefer roosts in the vicinity of water. Although they prefer to forage over water, they will also hunt in open areas where they catch moths, beetles, and other flying insects (CFW 2016).

Day and night roosts are inhabited during the spring, summer and fall months whereas during the winter, hibernacula (hibernation) sites are used. Day and night roost locations are chosen based upon the presence of stable ambient temperatures. They are used by active bats and include buildings, trees, areas under rocks, and piles of wood. Day roosts have very little or no light and provide good shelter. Nursery roosts are similar to day roosts but are warmer than ambient temperature and are usually only occupied by females and their offspring. Night roosts are selected for their confined spaces where large concentrations of bats can cluster together to increase the temperature of the roost and are occupied when the temperature is below 15 ^{o}C. Hibernation sites usually include abandoned mines or caves where the temperature is continuously above freezing, and humidity is high. Northern populations of bats enter hibernation in early September and end in mid-May (Havens 2006).

The results of the EcoRA did not indicate any residual effects on the little brown myotis from exposure to radiation during the post-closure phase of the NSDF Project, with the highest SI being 0.443 in scenario (15) What-IF – Human Intrusion, Mass Excavation and Farming (Table 5-4).

With respect to non-radiological exposure, potential residual effects were predicted for the little brown myotis from exposure to copper. For most scenarios, these exposures were dominated by background contaminant levels in soil but for scenarios (4), (14) and (15), releases from the NSDF Project during the post-closure phase contributed significantly to the exposure; however, these scenarios represent extreme circumstances that are highly unlikely to occur.

5.2.4.6 Monarch Butterfly

The monarch butterfly is listed as a species of special concern under SARA. The life cycle of the Monarch Butterfly (*Danaus plexippus*) consists of four stages; egg, the larvae (caterpillar), the pupa (chrysalis), and the adult butterfly. The eggs are laid exclusively on milkweed plants. They hatch into caterpillars (larvae). The caterpillar consumes the milkweed in order to grow. After about two weeks, the fully-grown caterpillar will attach itself to a stem or a leaf and is converted into a chrysalis. Later, during the metamorphosis process, the chrysalis is transformed into a butterfly. The Monarch Butterfly feeds on flowers. The life span of the Monarch Butterfly is only two to six weeks (WWF 2016).

The plant root uptake of COPCs from soil and groundwater is an exposure pathway and COPCs are likely present in the above ground parts of plants. Maximum exposure for the butterfly likely occurs during the caterpillar stage when it spends considerable time on plants. While the risks to the butterfly could not be quantified in the assessment, the SI values assessing risks of radiological exposure to terrestrial vegetation (Table 5-3) were below the benchmark value of 1 for all scenarios assessed, with the highest SI being 0.024, suggesting minimal exposure to the monarch butterfly. However, potential residual effects were predicted for terrestrial vegetation from exposure to copper which may signify potential effects to the monarch butterfly as well.

5.2.4.7 Snapping Turtle

The snapping turtle's *(Chelydra serpentine)* range extends from Ecuador to Canada. In Canada it can be found from Saskatchewan to Nova Scotia but is primarily limited to the southern part of Ontario (MNRF 2018a). These large reptiles face many threats including persecution by hunters and poachers, polluted environments and shrinking habitats. In Canada, the snapping turtle is listed as a species of special concern under SARA (WPC 2018).

The snapping turtle is Canada's largest freshwater turtle, reaching an average length of 20-36 cm and a weight of 4.5-16.0 kg. Although not a particularly good swimmer, it spends most of its life in water, preferring shallow waters so it can hide under the soft mud and leaf litter. During the nesting season, from early to mid-summer, females travel overland in search of a suitable nesting site. Nesting sites are usually gravelly or sandy areas along streams, but these turtles also take advantage of man-made structures including roads, dams and aggregate pits (MNRF 2018a). Snapping turtles usually enter hibernation by late October and emerge sometime between March and May, depending on latitude and temperature. To hibernate, they burrow into the debris or mud bottom of ponds or lakes, settle beneath logs, or retreat into muskrat burrows or lodges. Snapping turtles have been seen moving on or below the ice in midwinter. Large congregations sometimes hibernate together (U.S. EPA 1993). Snapping turtles are omnivores, feeding on various aquatic plants and invertebrates, as well as fish, frogs, snakes, small turtles, aquatic birds and dead animals (WPC 2018).

The results of the EcoRA did not indicate any residual effects on the snapping turtle from exposure to radiation during post-closure phases of the NSDF Project, with the highest SI being 1.02E-5 in Scenario (1a) NES SA - Inventory Sensitivity (Table 5-2). Sufficient information was not available for the non-radiological assessment of the snapping turtle.

6 UNCERTAINTIES

This section discusses uncertainties and conservatism in the EcoRA. As discussed in the CSA N288.6-12 (Clause 8, CSA 2012) standard, uncertainties exist in the EcoRA that need to be identified and evaluated for each stage of the risk assessment. Uncertainties will likely lead to an overestimation or underestimation of exposure, toxicity or risk and may occur in the following areas of the EcoRA:

(a) Problem formulation, as a result of available ecological and toxicological information;

(b) Exposure assessment, as a result of uncertainty in monitoring data and models;

(c) Toxicity/effects assessment, due to limited data for some ecological species, life stages, or endpoints of interest, or extrapolation from laboratory to field conditions; and,

(d) Risk characterization, due to uncertainties in exposure or toxicity, or uncertainties about the combined effects of multiple contaminants or physical stressors.

In recognition of these uncertainties, conservative assumptions were used throughout the assessment to ensure that the potential for a residual effect would not be underestimated. The major assumptions are outlined below.

- **Receptor Occupancy & Home Ranges:** All mobile receptors were assumed to be present in exposure locations for the entire year, despite any potential migratory behaviour. In addition, the home range of all mobile receptors was assumed to be limited to the location of maximum activities, when in reality, several mobile receptors have large home ranges and the location of a maximum concentration might represent only a small portion of their overall range. Thus, exposures are likely to be conservatively overestimated.

- **Receptor Characterizations/Exposure Parameters:** The characteristics of ecological receptors – mobile receptors in particular - represent another source of uncertainty since receptors will generally adjust and vary their diet and behaviour according to the food and water sources available and regional conditions. The characteristics (e.g., body weight; food, water, and soil consumption rates, etc.) for all receptors were selected based on a review of available information in various credible literature sources. However, for some (though not all) literature sources, these parameters are obtained from studies involving animals in captivity, and therefore may not be fully representative of free-range animals in the wild. An underestimate of exposure might result from this – for example, by assuming a body weight that is greater than for animals in the wild – but there are other conservative assumptions that may compensate (e.g., assuming the receptor spends all of its time on site in the exposure location).

- **Screening Procedure for Radiological COPCs:** In the screening process, if dose coefficients were not available for a radionuclide, then the radionuclide was ‘screened-out’ since the radiation dose associated with the radionuclide cannot be estimated without a dose coefficient. The exclusion of a radionuclide from the assessment because a dose coefficient is not available would result in an underestimation of the total dose and any potential effects. However, it should be noted that in this EcoRA, no radionuclide exceeding an environmental screening criterion was excluded from the assessment due to the lack of available dose coefficient.

- **Exposure Point Concentrations:** Predicted (modelled), as opposed to measured, radionuclide activities and contaminant concentrations were used in all of the scenarios assessed in the EcoRA. For each scenario, the EPCs were the maximum values predicted over time (10,000 years) in each environmental medium in the PostSA (Arcadis and Quintessa 2019) with added background for non-radiological COPCs (i.e., total concentrations). Using the peak activity/concentration (regardless of the time of the peak) for each environmental medium is conservative, as it ensures biota are assessed for the worst predicted exposure even though realistically these peaks would occur at different times (e.g., the soil peak concentration may occur at 100 years post-closure, but the creek peak concentration may occur hundreds of years later). As a result, exposures are likely to be conservatively overestimated.

- **Transfer Factors:** The concentrations/activities in biota had to be estimated using transfer factors from literature as well as food intake calculations. There is some uncertainty involved in the use of transfer factors and data that are not site-specific; however, in the absence of measured data, this approach provides the only method for estimating concentrations and for estimating transfer up the food chain. This is likely to conservatively overestimate doses.

- **Benchmark Values:** The benchmark values used in the assessment were obtained from reputable sources; nonetheless, they are always associated with uncertainty due to the extrapolation of testing on lab species (e.g., rats) to field conditions as well as to the ecological receptors considered in this assessment. This is likely to conservatively overestimate doses.

- **Toxicity Assessment:** As discussed in CSA N288.6-12 (CSA 2012), there is inherent uncertainty in the use of TRVs; however, the TRVs that were used were selected using a hierarchy of recent, credible sources, which include but are not limited to those recommended in CSA N288.6-12. These sources have already applied uncertainty factors to their TRVs. Therefore, while the inherent uncertainty in the TRVs cannot be removed, it has been controlled to the extent possible. It is also noted that toxicity information for a COPC was used regardless of its form in the test procedure, even though this may not be the same form used in the assessment (e.g., an oxide form compared to a more soluble form). It is difficult to determine the effect of these assumptions.

- **Risk Estimation:** The risk estimation reflects the uncertainties identified in the exposure assessment and toxicity assessment. This EcoRA did not include an assessment of multi-stressor effects, including interactions between contaminants. When dealing with toxic chemicals, there is potential interaction with other chemicals that may be found at the same location. It is well established that synergism, potentiation, antagonism or additivity of toxic effects occurs in the environment. A detailed quantitative assessment of these interactions is beyond the scope of the present study, and, for many COPC-receptor combinations there is not an adequate base of toxicological evidence to examine these interactions. This may result in an underestimate of the risk for some COPC combinations.

Table 6-1 provides a summary of the uncertainties discussed above. It can be seen from the table that, in general, the approaches or assumptions used to overcome uncertainties are likely to lead to an over-estimate of exposures and thus the conclusions of the assessment would remain unchanged.

Table 6-1 Summary of Uncertainties

Uncertainty	Likely Leads to Overestimate	Possibly Leads to Underestimate	Neither Overestimate or Underestimate
Use of maximum concentrations to characterize exposures.	X		
Use of transfer factors to estimate tissue concentrations.	X		
Use of literature characteristics for ecological receptors			X
Neglecting migratory behaviour, and home range fraction (i.e., assuming *all* ingested food, water, and soil is from within the study area).	X		
Use of laboratory-derived benchmarks for chronic exposure and effects.	X		
Use availability of DCs as screening criteria		X	
Use of laboratory-derived benchmarks for chronic exposure and effects.	X		
Synergism, potentiation, antagonism, additivity of toxic effects		X	

7 SUMMARY AND CONCLUSIONS

7.1 Radiological Assessment

All SI values calculated for the total radiation dose associated with each post-closure scenario were well below the benchmark value of 1 with the highest SI value being 0.443 (for the SARA species little brown myotis in scenario (15)). Based on these results, no potential residual effects to ecological receptors from radiological exposure were identified under any of the scenarios that were assessed for the post-closure phase of the NSDF Project. The results of the radiological exposure are summarized in Table 7-1.

Table 7-1 Results of Radiological Assessment

Post-closure Scenario	Radionuclides Assessed	Comment
(1) Normal Evolution Scenario and (9) Dose Optimization – Confidence in Land Use Restrictions	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	No potential residual effects to aquatic or terrestrial receptors were identified from exposure to radiation in any of the scenarios assessed.
(1a) NES Sensitivity Analysis - Inventory Sensitivity	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93, Am-241, C-14, Cl-36, Po-201, Pu-239, Ra-226, Th-228	
(1b) NES Sensitivity Analysis - Institutional Control Sensitivity	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(1c) NES Sensitivity Analysis - Sorption Coefficient Sensitivity	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93, Po-210, Ra-226, Th-228, Th232, U-234	
(1d) NES Sensitivity Analysis - Geosphere - Rapid Transit to Perch Creek	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(1e) NES Sensitivity Analysis - Enhanced Degradation of Cover and Liner	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(1f) NES Sensitivity Analysis - Global Warming - Reduced HER	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(3) Disruptive Event - Human Intrusion, House with Basement - Resident (Chronic)	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(4) Disruptive Event - Enhanced Erosion Case	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(5) Disruptive Event - Localized Cover Failure	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(6) Disruptive Event - Localized Liner Failure	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(7) Disruptive Event - Damage to Berm	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(8) Dose Optimization - Wastes Grouted into Steel Liners	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(11) Defence-in-Depth - Role of Geosphere	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	

Post-closure Scenario	Radionuclides Assessed	Comment
(12) Defence-in-Depth - Role of Cover	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(13) Defence-in-Depth - Role of Base Liner	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(14) Defence-in-Depth - Series of Landslides	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	
(15) What If - Human Intrusion, Mass Excavation and Farming	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93, Am-241, C-14, Cl-36, Po-201, Pu-239, Th-228	
(17) What If - Permanent Bathtub	Ac-227, Mo-93, Nb-93m, Pu-242, Th-229, U-233, Zr-93	

7.2 Non-radiological Assessment

Based on the quantitative assessment (SI values), potential residual effects due to aluminum, copper and lead exposure were identified for the ecological receptors summarized below in Table 7-2. This included both aquatic and terrestrial receptors in the Ottawa River, Perch Creek, Grazing Area and Garden Area as well as sitewide receptors and species at risk (Canada warbler, little brown myotis, eastern whip-poor-will, eastern wolf). The only receptors for which no potential residual effects were identified for any scenario were the bald eagle and great blue heron. However, with the exception of scenarios (4), (14) and (15) that simulate highly unlikely extreme events (see discussion below), the non-radiological exposures for all scenarios are overwhelmingly dominated by background exposure and are not the result of any incremental releases from the NSDF Project during the post-closure phase. Furthermore, the assessment results are very conservative in that they assume the maximum COPC concentrations predicted in each environmental medium over the entire post-closure assessment timeframe (10,000 years) and that each ecological receptor spends 100% of its time at the particular exposure location (i.e., Ottawa River, Perch Creek, Grazing Area or Garden Area, or the entire NSDF site for receptors with large home ranges).

Scenario 4: Disruptive Event - Enhanced Erosion Case:
This scenario is one of a group of scenarios assessed in the PostSA (Arcadis and Quintessa 2019) called Disruptive Events. Scenarios in this group involve variations that purposely challenge the integrity of the ECM and enhance potential exposures. Similar to the process followed for radioactivity, if an exposure exceeds a criterion, then the scenario is examined on a case-by-case basis, taking into account the likelihood and nature of the exposure. Accounting for the low probability expected for this scenario implies that the effective SI (taking likelihood into account) would be less than 1.0.

Scenario 14: Defence-in-Depth - Series of Landslides:
This scenario is one of a group of scenarios assessed in the PostSA (Arcadis and Quintessa 2019) called Defence-In-Depth. Defence-in-Depth scenarios are hypothetical in nature - they are used in the PostSA to test the robustness of the system. These scenarios highlight the importance of the different engineered barriers by producing results reflecting a hypothetical situation that arises if a particular barrier fails. This particular Defence-in-Depth scenario focusses on the role of the berm, and its results indeed illustrate the

fact that the berm is a key barrier. This is partly why the design of the berm has involved extensive investigations, focussing on topics such as seismicity and liquefaction, and why the design and construction involves removal and replacement of material beneath the berm to further strengthen the berm and bolster its stability.

Scenario 15: What If – Human Intrusion, Mass Excavation and Farming:
This scenario is one of a group of scenarios assessed in the PostSA (Arcadis and Quintessa 2019) called "What-If". "What-If" scenarios represent a hypothetical, deliberately extreme set of assumptions that can be used to understand the absolute limits to safety performance. These have been identified as potentially of interest in the same way as other scenarios and calculation cases but are discounted from the main set of assessment calculations on the basis that they are of very low or negligible likelihood. Nevertheless, they inform on the underlying bounds to post-closure safety and, as such, provide valuable perspective. However, due to their very low likelihood they need not be compared to any criteria.

Given that non-radiological exposures to non-human biota are dominated by background exposures except for scenarios representing highly unlikely extreme circumstances, the NSDF Project is predicted to have negligible residual effects.

Table 7-2 Summary of Potential Residual Effects to Ecological Receptors Quantified in the EcoRA

COPC	Post-closure Scenario	Location & Ecological Receptor	Comments
Al	Scenario (14)	Ottawa River: • benthic invertebrates • zooplankton • mallard Perch Creek: • aquatic vegetation • benthic fish • zooplankton • benthic invertebrates • pelagic fish • tadpole (green frog) • great blue heron • mallard • belted kingfisher	Ottawa River NSDF Project releases contribute significantly to exposure however, the scenario is an unlikely event. Perch Creek NSDF Project releases contribute significantly to exposure however, the scenario is an unlikely event.
Cu	For all post-closure scenarios except scenarios (4), (14) and (15)	Ottawa River: • benthic invertebrates • zooplankton Perch Creek: • zooplankton • benthic invertebrates • pelagic fish • tadpole (green frog)	Ottawa River & Perch Creek: >99% of the total exposure is contributed from background surface water conditions in the Ottawa River and Perch Creek and thus the NSDF Project has negligible residual effects.
	Scenarios (4) and (14)	Ottawa River: • benthic invertebrates • zooplankton	Ottawa River >98% of the total exposure is contributed from background surface water conditions in the Ottawa River and thus the NSDF Project has negligible residual effects.

COPC	Post-closure Scenario	Location & Ecological Receptor	Comments
		Perch Creek: • aquatic vegetation • benthic fish • zooplankton • benthic invertebrates • pelagic fish • tadpole (green frog) • mallard (scenario 5 only) Grazing Area: • Canada Warbler (SAR) • purple finch • ruffed grouse • short-tailed shrew • meadow vole • earthworm • terrestrial vegetation Sitewide • black bear • little brown myotis (SAR) • eastern whip-poor-will (SAR) • eastern wolf (SAR) • moose • white-tailed deer	Perch Creek NSDF Project releases contribute significantly to exposure however, the scenarios are unlikely events. Grazing Area: NDF Project releases contribute significantly to exposure however, the scenarios are unlikely events. Sitewide: NSDF Project releases contribute significantly to exposure however, the scenarios are unlikely events.
	Scenario (15)	Ottawa River: • benthic invertebrates • zooplankton Perch Creek:	Ottawa River & Perch Creek (aquatic biota): >99% of the total exposure is contributed from background surface water conditions in the Ottawa River and Perch Creek and thus the project has negligible residual effects.

COPC	Post-closure Scenario	Location & Ecological Receptor	Comments
		• zooplankton • benthic invertebrates • pelagic fish • tadpole (green frog) Grazing Area & Garden Area: • Canada Warbler (SAR) • purple finch • ruffed grouse • short-tailed shrew • meadow vole • earthworm • terrestrial vegetation Sitewide • black bear • little brown myotis (SAR) • eastern whip-poor-will (SAR) • eastern wolf (SAR) • moose • white-tailed deer	Grazing Area: NSDF Project releases contribute significantly to exposure however, the scenario is an extreme unlikely event. Sitewide: NSDF Project releases contribute significantly to exposure however, the scenario is an extreme unlikely event.
Pb	For all post-closure scenarios except scenarios (4), (14) and (15)	Ottawa River & Perch Creek: • benthic invertebrates Grazing Area & Garden Area: • Canada Warbler (SAR) Sitewide: • eastern-whip-poor-will (SAR)	Ottawa River & Perch Creek: >90% of the total exposure is contributed from background surface water conditions in the Ottawa River and Perch Creek and thus the NSDF Project has negligible residual effects. Grazing Area & Garden Area:

COPC	Post-closure Scenario	Location & Ecological Receptor	Comments
			>75% of the total exposure is contributed from background soil conditions in the Grazing Area and Garden Area and thus the NSDF Project has negligible residual effects. <u>Sitewide</u> >85% of the total exposure is contributed from background conditions and thus the NSDF Project has negligible residual effects.
	Scenario (4)	<u>Ottawa River & Perch Creek:</u> • benthic invertebrates <u>Grazing Area:</u> • Canada warbler (SAR) <u>Sitewide:</u> • eastern-whip-poor-will (SAR)	<u>Ottawa River & Perch Creek:</u> >75% of the total exposure is contributed from background surface water conditions in the Ottawa River and Perch Creek and thus the NSDF Project has negligible residual effects. <u>Grazing Area:</u> NSDF Project releases contribute significantly to exposure; main contributing pathways are earthworm (58%) and soil (42%) ingestion; however, the scenario is an unlikely event. <u>Sitewide</u> Total exposure dominated by NSDF Project releases; main contributing pathway is earthworm (100%) ingestion; however, the scenario is an unlikely event.
	Scenario (14)	<u>Ottawa River:</u> • benthic invertebrates <u>Perch Creek:</u> • benthic invertebrates	<u>Ottawa River:</u> >99% of the total exposure is contributed from background surface water conditions in the Ottawa River and thus the NSDF Project has negligible residual effects.

COPC	Post-closure Scenario	Location & Ecological Receptor	Comments
		• pelagic fish Grazing Area: • Canada warbler (SAR) Sitewide: • eastern-whip-poor-will (SAR)	Perch Creek: NSDF Project releases contribute significantly to exposure however, the scenario is an unlikely event. Grazing Area: NSDF Project releases contribute significantly to exposure; main contributing pathways are earthworm (58%) and soil (42%) ingestion; however, the scenario is an unlikely event. Sitewide NSDF Project releases contribute significantly to exposure; main contributing pathway is earthworm (100%) ingestion; however, the scenario is an unlikely event.
	Scenario (15)	Ottawa River & Perch Creek: • benthic invertebrates Grazing Area & Garden Area: • Canada warbler (SAR) Sitewide: eastern-whip-poor-will (SAR)	Ottawa River & Perch Creek: >90% of the total exposure is contributed from background surface water conditions in the Ottawa River and Perch Creek and thus the project has negligible residual effects. Grazing Area & Garden Area: NSDF Project releases contribute significantly to exposure; main contributing pathways are earthworm (58%) and soil (42%) ingestion; however, the scenario is an unlikely event. Sitewide NSDF Project releases contribute significantly to exposure; main contributing pathway is earthworm (100%) ingestion; however, the scenario is an unlikely event.

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APPENDIX A

Ecological Profiles

APPENDIX A: ECOLOGICAL PROFILES

The following tables provide the ecological profiles for the mammals and birds assessed in this EcoRA. Profiles are only provided for those receptors that are assessed quantitatively using pathways analysis as the characteristics are required for the pathways calculations.

A.1 American Black Bear *(Ursus americanus)*

Table A-1 American Black Bear Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	68	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.06	L/kg wet BW/day	L/d	4.08	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.03	kg dw/kg wet BW/day	g dw/d g ww/d	2040 6800	Environment Canada (2012) (FCSAP)	Calculated based on average body weight. Assuming an average water content of 70% for food items based on Tables 4-1 and 4-2 of 1993 U.S. EPA (1993).
Fraction of food that is fish	-	-	-	0.05	Environment Canada (2012) (FCSAP)	-
Fraction of food that is terrestrial vegetation	-	-	-	0.8	Environment Canada (2012) (FCSAP)	-
Fraction of food that is small mammals	-	-	-	0.1	Environment Canada (2012) (FCSAP)	Carrion in FCSAP, assumed to be small mammals.
Fraction of food that is soil invertebrates/ insects	-	-	-	0.05	Environment Canada (2012) (FCSAP)	Other (Insects, small mammals) in FCSAP, assumed to be earthworms.
Soil ingestion rate	4%	Estimated soil in diet (%)	g dw/d	81.6	Calculated from Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.04 and applying this to dry weight food ingestion rate.
Inhalation rate	-	-	m^3/d	83.1	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-20) for all mammals and applying a factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Canada Wildlife Service, 2015)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Predator and scavenger; high trophic level.
- **Life history:** Generally solitary, aside from mother-offspring bonding. Mating occurs in June to early July, with cubs being born in January to February (~6 month gestation period). Young bears grow rapidly and emerge with the mother in spring. Cubs remain with the mother for approximately 1.5 years, before becoming independent. Reproductive maturity is reached at approximately 3-5 years. Life expectancy ranges from approximately 10 years in the wild, to up to 25-30 years.
- **Importance to humans:** Commonly encountered species. Sometimes considered a nuisance when drawn to areas inhabited by humans. Black bears have important social, economic, and cultural significance.
- **Habitat:** Preferred habitat includes heavily wooded areas and dense bushland, especially coniferous forest.
- **Home range size:** Variable, large. Females: 10-40 km^2; Males: 100 km^2 or more.
- **Important population dynamics**: Winter hibernation.

A.2 Bald Eagle *(Haliaeetus leucocephalus)*

Table A-2 Bald Eagle Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	4.7	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.04	L/kg wet BW/day	L/d	0.188	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.12	kg ww/kg wet BW/day	g ww/d	564	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Fraction of food that is fish	-	-	-	0.65	Environment Canada (2012) (FCSAP)	-
Fraction of food that is bird	-	-	-	0.15	Environment Canada (2012) (FCSAP)	-
Fraction of food that is small mammal	-	-	-	0.2	Environment Canada (2012) (FCSAP)	-
Soil ingestion rate	5%	Estimated soil in diet (%)	g dw/d	5.91	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion rate as a fraction of dry weight diet of 0.05 and applying this to dry weight food ingestion rate.
Inhalation rate	-	-	m^3/d	2.3	U.S. EPA (1993)	Calculated using allometric equation (3-19) for all passerines and applying a factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Siciliano Martina, 2013)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** High trophic level. Predatory species. Eagle eggs are the most vulnerable and are prey for other birds and mammals.
- **Life history:** Generally solitary. Reproductive maturity is reached at 5 years. Mating and egg laying occurs at variable times depending on the population and its geography, with populations in northern locations (e.g., Alaska and northern Canada) having shorter seasons. Eggs hatch after 35 days of incubation. After approximately 8 -14 weeks fledging is complete, and at 18 weeks the young are independent. Estimated life expectancy in the wild is approximately 15 years.
- **Importance to humans:** Local populations in Ontario are listed as 'of special concern' (Ontario Species at Risk: http://www.ontario.ca/page/bald-eagle). The bald eagle has important spiritual and cultural value to many First Nation cultures.
- **Habitat:** Prefer areas near waterbodies including lakes, rivers, and coastlines.
- **Home range size:** Generally nest within 3 km of a waterbody, which is used as the primary food source. Home range can range from 6 to 47 km^2.
- **Important population dynamics:** Migratory behaviour varies; some populations only migrate locally, some not at all, others migrate south to the U.S. or east to the Atlantic Region.

A.3 Belted Kingfisher *(Megaceryle alcyon)*

Table A-3 Belted Kingfisher Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.155	Cornell (2017)	Weight range for both sexes is 140-170 g. Assumed 155 g.
Water ingestion rate	0.11	g/g wet BW/day	L/d	0.017	Calculated from U.S. EPA (1993)	Calculated based on average body weight.
Food ingestion rate	0.50	g ww/g wet BW/day	g dw/d g ww/d	19.4 77.5	Calculated from U.S. EPA (1993)	Calculated based on average body weight. For dry weight calculation, an average water content of 75% for fish was assumed based on Table 4-1 of U.S. EPA (1993).
Fraction of food that is fish	-	-	-	1.0	Cornell (2017)	Primarily piscivore feeding on sticklebacks, mummichogs, trout and stonerollers. They also eat crayfish and may eat other crustaceans, molluscs, insects, amphibians, reptiles, young birds, small mammals, and even berries.
Sediment ingestion rate	<2%	Estimated soil in diet (%)	g dw/d	0.388	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.02 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (blue-winged teal) from Beyer *et al.* (1994).

Parameter Description	Calculated from		Units	Value	Reference	Notes
Inhalation rate	-	-	m^3/d	0.094	U.S. EPA (1993)	-
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Cornell, 2017; Schablein, 2012)**:**

- **Trophic level or ecosystem role (e.g., predator or prey)**: Top predators in both marine and freshwater aquatic food webs. They have few natural predators, which may include accipiters and falcons, including Cooper's hawks, sharp-shinned hawks, and peregrine falcons.
- **Life history:** No information is available on lifespan. The breeding season occurs in April and May while pair bond is finishing construction of their nest.
- **Importance to humans:** Belted kingfishers are appreciated bird enthusiasts.
- **Habitat:** Belted kingfishers need access to water bodies for feeding and vertical earthen banks for nesting. Some of their most common habitats are streams, rivers ponds, lakes, estuaries, and calm marine waters. During the breeding season Belted kingfishers breed throughout most of North America at elevations up to 9,000 feet. They winter in similar habitats, as well as in mangroves, swamps, and brackish lagoons in the Central American parts of their wintering range.
- **Home range size:** The non-breeding territory is 300 to 500 m of shoreline (Schablein 2012).
- **Important population dynamics:** Resident to long-distance migrant. Kingfishers breed as far north as northern Alaska and Canada, and these birds migrate south for winter. They winter throughout Mexico and Central America to northern Venezuela and Colombia.

A.4 Canada Warbler (*Cardellina canadensis*)

Table A-4 Canada Warbler Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.011	Cornell (2017)	Weight range for both sexes is 9-13 g. Assumed 11 g.
Water ingestion rate	-	-	L/d	0.003	Calculated from U.S. EPA (1993)	Calculated based on average body weight using allometric equation for all birds (3-15) from U.S. EPA (1993).
Food ingestion rate	-	-	g dw/d g ww/d	3.1 8.8	Calculated from U.S. EPA (1993)	Dry weight calculated based on average body weight using allometric equation for all birds (3-3) from U.S. EPA (1993). Wet weight calculated assuming an average water content of 65% for insects based on Table 4-1 of U.S. EPA (1993).
Fraction of food that is soil invertebrates / insects	-	-	-	1.0	Cornell (2017)	Primarily insectivore feeding on a variety of insect and spider prey. They quickly hop between branches picking insects from understory vegetation in a flurry of activity and they also catch flying insects. Soil invertebrates assumed to be insects.
Soil ingestion rate	10.4%	Estimated soil in diet (%)	g dw/d	0.322	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.104 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (American woodcock) from Beyer *et al*. (1994).
Inhalation rate	-	-	m^3/d	0.025	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-19) for all non-passerines and applying a factor of 2 to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Cornell, 2017; Sherwick, 2012)**:**

- **Trophic level or ecosystem role (e.g., predator or prey)**: Low trophic level. Prey species for blue jays and milksnakes.
- **Life history:** Estimated wild lifespan is 8 years. The breeding season is from May through August.

- **Importance to humans:** Provide no economic benefit to humans.
- **Habitat:** Breed in mixed conifer and deciduous forest with a shrubby and mossy understory often near water. During migration they forage and rest in shrubby areas in parks, woodlots, and along forest edges. They winter in forests with dense undergrowth, forest edges, shade-coffee plantations, and scrubby fields across northern South America between 3,200 and 6,000 feet.
- **Home range size:** Average home range is 2 ha (Sherwick 2012)
- **Important population dynamics:** Canada warblers have a rapid migration in late spring and early fall. They are nocturnal and efficient travellers. They winter in Peru, Ecuador and Columbia.

A.5 Eastern Whip-Poor-Will *(Antrostomus vociferus)*

Table A-5 Eastern Whip-Poor-Will Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.053	Cornell (2017)	Weight range for both sexes is 43-64 g. Assumed 53 g.
Water ingestion rate	-	-	L/d	0.008	Calculated from U.S. EPA (1993)	Calculated based on average body weight using allometric equation for all birds (3-15) from U.S. EPA (1993).
Food ingestion rate	-	-	g dw/d g ww/d	8.6 24.6	Calculated from U.S. EPA (1993)	Dry weight calculated based on average body weight using allometric equation for all birds (3-3) from U.S. EPA (1993). Wet weight calculated assuming an average water content of 65% for insects based on Table 4-1 of U.S. EPA (1993).
Fraction of food that is soil invertebrates/ (flying) insects	-	-	-	1.0	Cornell (2017)	Nocturnal insectivore. Feeds exclusively on insects, including moths, beetles, grasshoppers, stoneflies, ants, bees, wasps, fireflies, and weevils. Soil invertebrates assumed to be insects.
Soil ingestion rate	-	-	-	negligible	Cornell (2017)	Soil ingestion assumed to be negligible as Whip-Poor-Wills are aerial foragers.
Inhalation rate	-	-	m^3/d	0.043	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-19) for all non-passerines from U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Environment Canada, 2015; National Audubon Society, 2018)**:**

- **Trophic level or ecosystem role (e.g., predator or prey)**: Low trophic level. As a ground nester, the species may be particularly vulnerable to nest predation (EC 2015).
- **Life history:** Estimated average life expectancy is 4 years. The nest site is on ground, in shady woods but often near the edge of a clearing, on open soil covered with dead leaves. Nesting activity may be timed so that adults are feeding young primarily on nights when moon is more than half full, when moonlight makes foraging easier for them.
- **Importance to humans:** Control pest insect species.
- **Habitat:** Leafy woodlands. Breeds in rich moist woodlands, either deciduous or mixed. Winter habitats are also in wooded areas.
- **Home range size:** Can range from 20 to 500 ha (mean 136 ha) (EC 2015).
- **Important population dynamics:** Breed in deciduous or mixed woods across central and south-eastern Canada and the eastern United States and migrate to the south-eastern United States and to eastern Mexico and Central America for the winter.

A.6 Eastern Wolf *(Canis lycaon)*

Table A-6 Eastern Wolf Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	43	Schmidt and Gilbert (1978)	-
Water ingestion rate	-	-	L/d	2.92	U.S. EPA (1993)	Calculated based on average body weight using allometric equation for all mammals (3-17) from U.S. EPA (1993).
Food ingestion rate	5.5	kg wet food/d	g dw/d g ww/d	1760 5500	Fuller and Keith (1980)	Dry weight calculated assuming an average water content of 68% for mammals based on Table 4-1 of U.S. EPA (1993).
Fraction of food that is small mammals	-	-	-	0.8	Smith (2002)	Assumed based on information provided by Smith (2002).
Fraction of food that is deer	-	-	-	0.2	Smith (2002)	Assumed based on information provided by Smith (2002).
Soil ingestion rate	2.8%	Estimated soil in diet (%)	g dw/d	49.28	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.028 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (red fox) from Beyer *et al*. (1994).
Inhalation rate	-	-	m^3/d	22.12	U.S. EPA (1993)	Calculated using allometric equation (3-20) for all mammals from U.S. EPA (1993) and applying a factor of two to

Parameter Description	Calculated from		Units	Value	Reference	Notes
						account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	-	Assumed home range within site.

Notes (Smith, 2002)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** High trophic level; predator (carnivores, eats terrestrial vertebrates).
- **Life history:** The average lifespan is 5 to 6 years, with up to 13 years in the wild.
- **Importance to humans:** Identified important in controlling the population of their prey. Their body parts are used as a source of valuable material. They may also boost the ecotourism.
- **Habitat:** Found in a wide variety of habitats, from arctic tundra to forest, prairie, and arid landscapes.
- **Home range size:** 130 to 13000 km^2.
- **Important population dynamics:** Wolves are pack living animals with a pack leader which is usually an alpha male. They are active during the night and can travel up to 200 km daily. The breeding season is between January and April. The northern populations breed later in the season than southern populations.

A.7 Great Blue Heron *(Ardea herodias)*

Table A-7 Great Blue Heron Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	2.3	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.04	L/kg wet BW/day	L/d	0.092	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.18	kg wet food/kg wet BW/day	g dw/d g ww/d	103.5 414	Environment Canada (2012) (FCSAP)	Calculated based on average body weight. For dry weight calculation, an average water content of 75% for fish was assumed based on Table 4-1 of U.S. EPA (1993).
Fraction of food that is fish	-	-	-	0.65	Environment Canada (2012) (FCSAP)	-
Fraction of food that is small mammals	-	-	-	0.25	Environment Canada (2012) (FCSAP)	-

Parameter Description	Calculated from		Units	Value	Reference	Notes
Fraction of food that is benthic invertebrates	-	-	-	0.1	Environment Canada (2012) (FCSAP)	-
Sediment ingestion rate	2%	Estimated soil diet (%)	g dw/d	2.07	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.02 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (blue-winged teal and ringed-necked duck) from Beyer *et al*. (1994).
Inhalation rate	-	-	m^3/d	0.7	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-19) for all passerines from U.S. EPA (1993) and an applied factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	-	Assumed home range within site

Notes (Naumann, 2011)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Mid trophic level; predator carnivores.
- **Life history:** The average lifespan for these species is around 15 years. There is mortality rate of 60% among the young herons before they reach 1 years old.
- **Importance to humans:** No known benefit to humans.
- **Habitat:** Live near sources of water, including rivers, lake edges, marshes, saltwater seacoasts, and swamps.
- **Forage range size:** 16.6 to 2827 km^2.
- **Important population dynamics:** Mostly migratory.

A.8 Green Frog *(Rana clamitans)*

Table A-8 Green Frog Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.049	U.S. EPA (1993)	-
Water ingestion rate	-	-	g/d	Not available	U.S. EPA (1993)	No allometric equation was available amphibians.
Food ingestion rate	-	-	g ww/d	Not available	U.S. EPA (1993)	No allometric equation was available amphibians.
Fraction of food that is soil invertebrates	-	-	-	0.8	U.S. EPA (1993)	Reportedly, frogs feed on insects, worms, small fish, crayfish, other crustaceans, newts, spiders, small frogs, and molluscs. Terrestrial beetles often made their most important food item. It was assumed that 80% of their dietary composition is soil invertebrates, while benthic organisms form about 20% of their diet.
Fraction of food that is benthic	-	-	-	0.2	U.S. EPA (1993)	Assumed. See above.
Sediment ingestion rate	-	-	g dw/d	Not available	U.S EPA (1993)	Based on provided dietary habit of frogs, sediment ingestion is considered to be negligible.
Inhalation rate	-	-	m^3/d	NA	U.S. EPA (1993)	. -
Fraction of time at site	-	-	-	1	-	Assumed home range within site

Notes (Gillilland, 2000)*:*

- **Trophic level or ecosystem role (e.g. predator or prey):** low trophic level; prey, carnivore (amphibians, reptiles, insects, terrestrial non-insect arthropods, molluscs, terrestrial worms, aquatic crustaceans, zooplankton) and herbivore (algae).
- **Life history:** green frogs can live up to 10 years in captivity, however the average lifespan in wild is unknown.
- **Importance to humans:** occasionally used as a food source. Furthermore, they are used for research and educational purposes.
- **Habitat:** they are found in a wide variety of habitats surrounding the inland waters such as swamps, wooded swamps, ponds, lakes, marshes, slow moving waters, etc.
- **Home range size:** 0.9 to 6.1 m in diameter.
- **Important population dynamics:** green frogs are active during the day and night. During the cold weather, they become less active. Breeding take place in late spring, however, the geographic conditions particularly the temperature can affect the breeding time (Gillilland 2000).

A.9 Little Brown Myotis *(Myotis lucifugus)*

Table A-9 Little Brown Myotis Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.0095	Havens (2006)	Average of range reported by Havens (2006).
Water ingestion rate	-	-	L/d	0.0015	U.S. EPA (1993)	Calculated based on average body weight using allometric equation for all mammals (3-17) from U.S. EPA (1993).
Food ingestion rate	kg wet food/d	0.006	g ww/d	6	U.S. EPA (1993)	-
Fraction of food that is benthic invertebrates / insects	-	-	-	0.5	Havens (2006)	Assumed based on information from Havens (2006). Assumed benthic invertebrates represent insects on surface water.
Fraction of food that is soil invertebrates / insects	-	-	-	0.5	Based on Havens (2006)	Assumed based on information from Havens (2006). Assumed soil invertebrates represent flying insects.
Soil ingestion rate	-	-	g dw/d	negligible	-	Consumes flying insects and insects on water surface. Assumed negligible.
Inhalation rate	-	-	m^3/d	0.0189	MOE (2011)	-
Fraction of time at site	-	-	-	1	-	Assumed home range within site.

Notes (Havens, 2006)**:**

- **Trophic level or ecosystem role (e.g. predator or prey):** mid trophic level; prey, carnivore (insectivore).
- **Life history:** The average lifespan for this species is 6 to 7 years and often they live to more than 10 years. The survival rate in their first year of life is the lowest.
- **Importance to humans:** They control pest population and are widely used in research and education.
- **Habitat:** They have three types of roosts, day, night, and hibernation roosts. Day and night roosts include buildings, trees, under rocks, and in piles of wood and are used during spring, summer and fall. Day roosts have very little or no light, while the night roosts are used as confined spaces where large numbers of bats can live together when the temperature is below 15 °C. Hibernacula in Western Canada may be shared with Yuma myotis. Hibernacula in Ontario may be shared with northern myotis, eastern small-footed myotis and sometimes the tri-colored bat. These sites usually include abandoned mines or caves where the temperature is continuously above freezing, and humidity is high.
- **Home range size:** Travel several kilometers between day roosts and feeding sites.
- **Important population dynamics:** They are active during the night, about two or three hours after dusk and before dawn. They return to their roosts by half an hour before sunrise. The hibernation time depends on the location of the roosts and it usually starts between September and November and ends in March to May. Hibernacula can host large numbers of bats, up to 300,000 individuals have been reported in a single roost.

A.10 Mallard *(Anas platyrhynchos)*

Table A-10 Mallard Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	1.2	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.06	L/kg ww BW/day	L/d	0.072	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.05	kg dw/kg ww BW/day	g dw/d g ww/d	60 300	Environment Canada (2012) (FCSAP)	Calculated based on average body weight. A water content of 80% for diet was assumed based on range of values for dietary items in Tables 4-1 and 4-2 of EPA (1993).
Fraction of food that is benthic invertebrates	-	-	-	0.4	Environment Canada (2012) (FCSAP)	-
Fraction of food that is aquatic vegetation	-	-	-	0.5	Environment Canada (2012) (FCSAP))	-
Fraction of food that is terrestrial vegetation	-	-	-	0.05	Environment Canada (2012) (FCSAP)	-
Fraction of food that is fish	-	-	-	0.025	Environment Canada (2012) (FCSAP)	Identified as Other (ground insects, flying insects, fish) in FCSAP, assumed to be 50% fish 50% earthworms.
Fraction of food that is soil invertebrates/ insects	-	-	-	0.025	Environment Canada (2012) (FCSAP)	Identified as Other (ground insects, flying insects, fish) in FCSAP, assumed to be 50% fish 50% earthworms.
Sediment ingestion rate	3.3%	Estimated soil in diet	g dw/d	1.98	Environment Canada (2012) (FCSAP)	Calculated as 3.3% of dry food ingestion rate.
Inhalation rate	-	-	m^3/d	0.9	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-19) for all passerines and applying a factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Rogers, 2001)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Low trophic level; prey species.
- **Life history:** Pairing between mates occurs from October to March. Mating occurs in the spring. Females lay a 9-13 egg clutch. Eggs hatch after 26-28 days. Young are led to nearby water, and the nest is abandoned. After 10 weeks the young have matured, and the mother leaves them to be independent. Reproductive maturity is reached at 1 year. Estimated life expectancy can be as high as 25+ years.
- **Importance to humans:** Key species for hunting.

- **Habitat:** Wetlands, particularly where waters produce large amounts of floating, emergent, and submergent vegetation.
- **Home range size:** N/A.
- **Important population dynamics:** Varies by population, but generally migratory. Some overwinter in Southern Ontario, others do not migrate.

A.11 Meadow Vole *(Microtus pennsylvanicus)*

Table A-11 Meadow Vole Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.0349	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.21	L/kg ww BW/d	L/d	0.007	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.33	kg ww/kg ww BW /d	g ww/d	11.5	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Fraction of food that is terrestrial vegetation	-	-	-	1	Environment Canada (2012) (FCSAP)	-
Soil ingestion rate	2.4%	Estimated soil in diet	g dw/d	0.083	Environment Canada (2012) (FCSAP)	Assuming a 70% water content for terrestrial vegetation.
Inhalation rate	1.02	m^3/kg/d	m^3/d	0.0356	Environment Canada (2012) (FCSAP)	-
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Rowe, 2017)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Low trophic level; prey species.
- **Life history:** Estimated life expectancy in the wild is very short, rarely living for longer than one year.
- **Importance to humans:** Maintains ecosystem balance as an important prey food source for several other mammals and birds. Can be a pest species in large numbers, by consuming crops.
- **Habitat:** Prefers meadows, lowland fields, marshes, river banks and lake shorelines.
- **Home range size:** N/A
- **Important population dynamics:** The meadow vole is active during the day but tends to be more active during night time in summer and daytime in winter. They dig runways through vegetation where they hide feces and food waste.

A.12 Moose *(Alces alces)*

Table A-12 Moose Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	400	Environment Canada (2012) (FCSAP)	Average: 400 kg Male: 453 kg Female: 350 kg
Water ingestion rate	0.05	L/kg ww BW/day	L/d	20	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.02	kg dw/kg ww BW/day	g dw/d g ww/d	8000 53333	Environment Canada (2012) (FCSAP)	Calculated based on average body weight. A water content of 85% was assumed for dietary items based on water content of food items presented in Table 4-2 of U.S. EPA (1993).
Fraction of food that is terrestrial vegetation	-	-	-	0.8	Environment Canada (2012) (FCSAP)	Woody matter consisting of shrubs and trees (twigs and branches). Willow is most commonly consumed but may also consume in great quantities twigs of trembling aspen, saskatoon, birch and redosier dogwood.
Fraction of food that is aquatic vegetation	-	-	-	0.2	Environment Canada (2012) (FCSAP)	Aquatic vegetation consumed due to high sodium content. In the summer they may feed on aquatic vegetation such as horsetail, bur-reed and pondweed.
Sediment ingestion rate	2	%	g dw/d	160	Environment Canada (2012) (FCSAP)	calculated as 2% of dry food ingestion rate (given as <2% in documentation)
Inhalation rate	-	-	m^3/d	132	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-20) for all mammals from U.S. EPA (1993) and an applied factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	-	Assumed home range within site.

Notes (Environment Canada, 2012; UW-SP Wildlife Ecology website, online; Wikipedia, online)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Low trophic level; herbivorous. Prey species to wolves, grizzly bears, black bears and humans.
- **Life history:** Moose are generally solitary with the strongest bonds between mother and calf. Although moose rarely gather in groups, several may occur in close proximity during the mating season. Mating occurs in September and October. Female moose have an eight-month gestation period, usually bearing one calf, or twins if food is plentiful, in May or June. The young will stay with the mother until just before the next young are born. The calves are helpless at birth and the mother will keep them in seclusion for a couple of days, hidden from their main enemies in a thicket or on an island. The life span of an average moose is about 15-25 years.
- **Importance to humans:** Moose are hunted as a game species in many of the countries where they are found including Canada. Although slow-moving and sedentary, moose can become aggressive and move quickly if angered or startled.
- **Habitat:** Moose are found only in the northern hemisphere. The general habitat type is forest and wetland and more specifically boreal, northern and subalpine forests. Moose are common in recently disturbed habitats where there is a mix of young and old forest stands as well as diverse browse species.
- **Home range size:** Habitat sizes for the moose vary considerably with the geographic location and method of calculation, ranging from 4.6 to 262 km^2.
- **Important population dynamics:** Migration occurs if the benefit of leaving is greater than the benefit of staying within an individual's home range. Often times the purpose of migration is to place an animal into an optimal mating environment. Moose generally spend winters in a communal winter range and summers in a more secluded range. The distance between summer and winter ranges tends to be a function of habitat dispersion and type of terrain. In northwestern Minnesota the migration distances were found to be between 14.0 – 34.1 km and in Alaska 15.9 – 93.0 km. The specific timing of migration varies from year to year and is heavily influenced by climate. Migratory moose will follow the same path for each migration session.

A.13 Northern Short-tailed Shrew *(Blarina brevicauda)*

Table A-13 Northern Short-Tailed Shrew Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.015	MOE (2011)	-
Water ingestion rate	-	-	L/d	0.00226	U.S. EPA (1993)	Calculated based on average body weight using allometric equation for all mammals (3-17) from U.S. EPA (1993).
Food ingestion rate	-	-	kg wet food/d	0.009	MOE (2011)	-
Fraction of food that is soil invertebrates	-	-	-	1	MOE (2011)	-
Soil ingestion rate	-	-	g dw/d	0.187	MOE (2011)	-
Inhalation rate	-	-	m^3/d	0.0189	MOE (2011)	-
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Ballenger, 2011)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Low trophic level; prey.
- **Life history:** The survival rate in their first year of life is high. They can live as long as 3 years.
- **Importance to humans:** They control pest population.
- **Habitat:** Found in all terrestrial habitats, however their population is most dense in damp brushy woodlands, bushy bogs and marshes, and weedy and bushy borders of fields.
- **Home range size:** 2.5 ha.
- **Important population dynamics:** They are active year around while they are more active during the night than the daytime. They are effective in tunnelling through leaves, plants and snow. Most of their time is spent on or under the ground, but they also climb trees to get suet from a bird feeder. In captivity, they live together, however in the wild, they are unsociable and will have their own territory.

A.14 Purple Finch *(Haemorhous purpureus)*

Table A-14 Purple Finch Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.024	Cornell (2017)	Weight range for both sexes is 18-32 g. Assumed 24 g.
Water ingestion rate	-	-	L/d	0.005	Calculated from U.S. EPA (1993)	Calculated based on average body weight using allometric equation for all birds (3-15) from U.S. EPA (1993).
Food ingestion rate	-	-	g dw/d g ww/d	5.1 5.6	Calculated from U.S. EPA (1993)	Dry weight calculated based on average body weight using allometric equation for all birds (3-3) from U.S. EPA (1993). Wet weight calculated assuming an average water content of 9.3% for seeds based on Table 4-2 of U.S. EPA (1993).
Fraction of food that is seeds/fruit	-	-	-	1.0	Cornell (2017)	Mainly feed on seeds of coniferous trees and elms, tulip poplars, maples and others. They also eat many berries and fruit, including blackberries, honeysuckle, poison ivy, crab-apples, juniper berries, cherries, and apricots. They eat some insects, including aphids, caterpillars, grasshoppers, and beetles.
Soil ingestion rate	9.3%	Estimated soil in diet (%)	g dw/d	0.474	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.093 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (wild turkey) from Beyer *et al.* (1994).
Inhalation rate	-	-	m^3/d	0.046	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-19) for all non-passerines and applying a factor of 2 to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Cornell, 2017; Ryder, 2015; Sterling, 2011)**:**

- **Trophic level or ecosystem role (e.g., predator or prey)**: Low trophic level. Vulnerable to nest predation by blue jays, scrub jays, Clark's nutcrackers, common grackles, and red squirrels. Adults also fall prey to blue jays, barn owls, merlins, sharp-shinned hawks, American kestrels and domestic dogs. As primarily a seed eater, it may be an important seed disperser for plants on which it feeds.
- **Life history:** Average wild lifespan is estimated at 2 years. The breeding season is between April and August.
- **Importance to humans:** Provide little economic benefit to humans.
- **Habitat:** Breed mainly in coniferous forests or mixed deciduous and coniferous woods. During winter they can be found in a wider variety of habitats, including shrublands, old fields, forest edges, and backyards.
- **Home range size:** N/A
- **Important population dynamics:** Short distance migrant. Migratory, but its entire range is contained within North America. Breeding range spans northern North America roughly coincident with the Boreal Forest. This bird winters within the southern part of its breeding range and across most of eastern North America.

A.15 Snapping Turtle (*Chelydra serpentina*)

Table A-15 Snapping Turtle Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	7.9	U.S. EPA (1993)	Average of mean body weights for male (10.5 kg ± 2.85 SD) and female (5.24 kg ± 0.85 SD) snapping turtles.
Water ingestion rate	0.02	g/g wet BW/d	g/d L/d	158 0.158	U.S. EPA (1993)	Calculated using water ingestion rate for painted turtle (U.S. EPA 1993) and body weight for snapping turtle.
Food ingestion rate	-	-	g dw/d g ww/d	36.0 180	U.S. EPA (1993)	Based on the allometric equation provided in U.S. EPA (1993) for reptiles and amphibians (Equation 3-10 for herbivores). It should be noted that the developed allometric equation is for iguanid lizards, which is the only information of this type that has been identified for any amphibian or reptile. An average 80% moisture content was assumed for food items.

Parameter Description	Calculated from		Units	Value	Reference	Notes
Fraction of food that is fish	-	-	-	0.6	Assumed based on U.S. EPA (1993)	Snapping turtles are omnivores that consume a wide variety of animal material including insects, crustaceans, clams, snails, earthworms, leeches, tubificid worms, freshwater sponges, fish, frogs and toads, salamanders, snakes, small turtles, birds, mammals and carrion and plant material including various algae (U.S. EPA 1993).
Fraction of food that is plants	-	-	-	0.4	Assumed based on U.S. EPA (1993)	
Sediment ingestion rate	5.2%	Estimated soil in diet (%)	g dw/d	1.87	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.052 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (average of box turtle and Eastern painted turtle) from Beyer *et al*. (1994).
Inhalation rate	0.0025	m^3/kg-d	m^3/d	0.020	U.S. EPA (1993)	Calculated using inhalation rate for painted turtle (U.S. EPA 1993) and body weight for snapping turtle.
Fraction of time at site	-	-	-	1	-	Assumed home range within site.

Notes (U.S. EPA, 1993):

- **Trophic level or ecosystem role (e.g., predator or prey):** Mid trophic level; prey, omnivore.
- **Life history:** Studies included in U.S. EPA (1993) reported Snapping Turtles to live at least 19 and 24 years.
- **Importance to humans:** Turtles are prominent in the beliefs and ceremonies of many First Nations peoples (Bell et al. 2010).
- **Habitat:** In the east, Snapping Turtles are found in and near permanent ponds, lakes, and marshes, typically in turbid waters with slow current. They spend most of their time being buried in mud in shallow water with only their eyes and nostrils exposed (U.S. EPA 1993).
- **Home range size:** Most Snapping Turtles stay primarily within the same marsh or in one general area from year to year. The summer home range of male Snapping Turtles in Ontario lakes was reported to range from 0.24 to 1.3 ha and for females from 2.15 to 5.19 ha (U.S. EPA 1993).
- **Important population dynamics:** They usually enter hibernation by late October and emerge sometime between March and May.

A.16 Ruffed Grouse *(Bonasa umbellus)*

Table A-16 Ruffed Grouse Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	0.552	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.07	L/kg wet BW/d	L/d	0.0386	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.06	kg dw food/kg wet BW/d	g dw/d g ww/d	33.1 125	Environment Canada (2012) (FCSAP)	A moisture content of 70% for terrestrial vegetation and 84% for invertebrates was assumed.
Fraction of food that is terrestrial vegetation	-	-	-	0.85	Environment Canada (2012) (FCSAP)	-
Fraction of food that is soil invertebrates/ insects	-	-	-	0.15	Environment Canada (2012) (FCSAP)	Insects and invertebrates.
Soil ingestion rate	9.85%	Estimated soil in diet (%)	g dw/d	3.3	Beyer *et al.* (1994)	Calculated using an assumed soil ingestion as a fraction of dry weight diet of 0.0985 and applying it to the dry weight food ingestion rate. Soil fraction based on Table 1 (American woodcock and wild turkey) from Beyer *et al.* (1994).
Inhalation rate	-	-	m^3/d	0.52	U.S. EPA (1993)	Calculated using allometric equation (3-19) for all birds from U.S. EPA (1993b) and applying a factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	Assumed	-

Notes (Haupt, 2001)**:**

- **Trophic level or ecosystem role (e.g. predator or prey):** Low trophic level; prey species, omnivore.
- **Life history:** Estimated life expectancy in the wild is 102 months.
- **Importance to humans:** It is hunted for sport. Decreases insect population during the hatching season.
- **Habitat:** Prefers the forested areas in rough, cold lands. It also favours dim and quiet woods, deep thickets, or sheltered swamps. It doesn't like the open fields.
- **Home range size:** 1 ha.
- **Important population dynamics:** They are solitary birds which prefer living alone except during the mating season. Average hatching time is 24 days and the clutch is about 11 eggs per season.

A.17 White Tailed Deer *(Odocoileus virginianus)*

Table A.16 White-tailed Deer Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight	-	-	kg	75	Environment Canada (2012) (FCSAP)	-
Water ingestion rate	0.06	L/kg ww BW/day	L/d	4.5	Environment Canada (2012) (FCSAP)	Calculated based on average body weight.
Food ingestion rate	0.03	kg dw/kg ww BW/day	g dw/d g ww/d	2250 7500	Environment Canada (2012) (FCSAP)	Calculated based on average body weight. A water content of 70% was assumed for dietary items based on water content of food items presented in Table 4-1 and 4-2 of U.S. EPA (1993).
Fraction of food that is terrestrial vegetation	-	-	-	1	Environment Canada (2012) (FCSAP)	-
Soil ingestion rate	2	%	g dw/d	45	Environment Canada (2012) (FCSAP)	calculated as 2% of dry food ingestion rate (given as <2% in documentation)
Inhalation rate	-	-	m^3/d	34.5	Calculated from U.S. EPA (1993)	Calculated using allometric equation (3-20) for all mammals and applying a factor of two to account for free-living metabolic rates, as directed by U.S. EPA (1993).
Fraction of time at site	-	-	-	1	-	Assumed home range within site.

Notes (Dewey, 2003)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Low trophic level; herbivorous. Prey species.
- **Life history:** Generally solitary, or paired mother and offspring. Mating occurs from October to December, followed by a 6 month gestation period. Young are born able to walk, can eat vegetation within days, follow the mother on foraging trips at 4 weeks, and are fully ruminant at 8 weeks. Weaning is complete after approximately 10 weeks. Young males leave the mother and are independent after 1 year; young females after 2 years. Typical life expectancy is 2-3 years in the wild, with few living past 10 years.
- **Importance to humans:** Commonly encountered species. Key species for hunting. Sometimes considered a nuisance when affecting areas inhabited by humans, typically through crop damage.
- **Habitat:** Highly variable. Prefer forested areas.
- **Home range size:** Generally small, often 1 km^2.
- **Important population dynamics:** Not migratory.

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APPENDIX B

Sample Calculations for Radiological and Non-Radiological Doses

SAMPLE CALCULATIONS FOR RADIOLOGICAL DOSES

Normal Evolution Scenario

NB-93M INTAKE BY BALD EAGLE - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	4.7	
Water ingestion rate	L/d	Qwat	0.188	
Fresh weight food ingestion rate	g FW/d	Qffw	564	
Soil ingestion rate	g DW/d	Qsdw	5.91	
Fraction that is fish	-	ffi	0.65	
Fraction that is birds	-	fbd	0.15	
Fraction that is small mammals	-	fsm	0.20	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	2.93E-04	Sitewide - 50% Perch Creek, 50% Ottawa River
Soil concentration	Bq/kg dw	Cs	2.85E+02	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Water to fish (Whole)	L/kg (fw)	TFfish	300	assumed same as flesh
Whole fish concentration (FW)	Bq/kg fw	Cfishfw	8.80E-02	=Cw*TFfish
Bird concentration (FW)	Bq/kg fw	Cbirdsfw	4.48E-03	average of Purple Finch, Canada Warbler and Eastern-whip-poor-will (see calculations below)
Small Mammal concentration (FW)	Bq/kg fw	Csmfw	1.72E-04	average of short-tailed shrew and meadow vole (see calculations below)
Calculation of Intakes				
Intake from water	Bq/kg-d	Iw	1.17E-05	=Qwat*Cw*Floc/BW
Intake from soil	Bq/kg-d	Is	3.59E-01	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from fish	Bq/kg-d	Ifi	6.87E-03	=Qffw*ffi*Cfishfw*1kg/1000g*Floc/BW
Intake from birds	Bq/kg-d	Ibirds	8.07E-05	=Qffw*fbd*Cbirdsfw*1kg/1000g*Floc/BW
Intake from small mammals	Bq/kg-d	Ism	4.14E-06	=Qffw*fsm*Csmfw*1kg/1000g*Floc/BW
Total intake	Bq/kg-d	Itot	3.66E-01	=Iw+Is+Ifi+Ibirds+Ism
Estimated Concentration of Bald Eagle				
Feed to Bald Eagle TF	d/kg (FW)	TFeagle	1.58E-04	
Estimated Bald Eagle Conc	Bq/kg (FW)	Ceagle	2.72E-04	=Itot*BW*TFeagle
Estimated Dose				
Internal Dose Coefficient	Gy/y per Bq/kg FW	DC_int	1.53E-07	Amiro
Internal Dose	mGy/d	D_int	1.14E-10	=Ceagle x DC_int x 1000 (mGy/Gy) / 365 (d/y)
External Dose Coefficient - On Soil	Gy/y per Bq/kg DW	DC_ext_onSoil	1.34E-08	Amiro
Occupancy factor on soil/sediment surface	unitless	OFss	1	Assumed
External Dose - On Soil	mGy/d	D_ext_onSoil	1.05E-05	= Cs x DC_ext_onSoil x OFss x 1000 (mGy/Gy) / 365 (d/y)
Total Dose	mGy/d	D_total	1.05E-05	= D_int + D_ext_onSoil

Normal Evolution Scenario

NB-93M INTAKE BY PURPLE FINCH - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.024	
Water ingestion rate	L/d	Qwat	0.005	
Fresh weight food ingestion rate	g FW/d	Qffw	5.6	
Soil ingestion rate	g DW/d	Qsdw	0.47	
Fraction that is seeds	-	fseed	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	5.86E-04	Perch Creek
Soil concentration	Bq/kg dw	Cs	2.85E+02	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to seeds	kg/kg dw	TFseeds	0.029	CSA 2018 Table G.3
Seeds moisture content	-	MCseeds	9.3%	U.S. EPA 1993
Seeds concentration (DW)	Bq/kg dw	Cseedsdw	8.27E+00	=Cs*TFseeds
Seeds concentration (FW)	Bq/kg fw	Cseedsfw	7.51E+00	=Cseedsdw*(1-MCseeds)
Calculation of Intakes				
Intake from water	Bq/kg-d	Iw	1.22E-04	=Qwat*Cw*Floc/BW
Intake from soil	Bq/kg-d	Is	5.64E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from seeds	Bq/kg-d	Iseed	1.76E+00	=Qffw*fseed*Cseedsfw*1kg/1000g*Floc/BW
Total intake	Bq/kg-d	Itot	7.40E+00	=Iw+Is+Iseed
Estimated Concentration of Purple Finch				
Feed to Purple Finch TF	d/kg (FW)	TFfinch	8.27E-03	
Estimated Purple Finch Conc	Bq/kg (FW)	Cfinch	1.47E-03	=Itot*BW*TFfinch

NB-93M INTAKE BY CANADA WARBLER - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.011	
Water ingestion rate	L/d	Qwat	0.003	
Fresh weight food ingestion rate	g FW/d	Qffw	8.8	
Soil ingestion rate	g DW/d	Qsdw	0.32	
Fraction that is earthworms	-	few	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	5.86E-04	Perch Creek
Soil concentration	Bq/kg dw	Cs	2.85E+02	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to earthworm	kg/kg dw	TFew	0.95625	ERICA 2019
Earthworm moisture content	-	MCew	84.0%	U.S. EPA 1993
Earthworm concentration (DW)	Bq/kg dw	Cewdw	2.73E+02	=Cs*TFew
Earthworm concentration (FW)	Bq/kg fw	Cewfw	4.37E+01	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	Bq/kg-d	Iw	1.60E-04	=Qwat*Cw*Floc/BW
Intake from soil	Bq/kg-d	Is	8.36E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from earthworm	Bq/kg-d	Iew	3.49E+01	=Qffw*few*Cewfw*1kg/1000g*Floc/BW
Total intake	Bq/kg-d	Itot	4.33E+01	=Iw+Is+Iew
Estimated Concentration of Canada Warbler				
Feed to Canada Warbler TF	d/kg (FW)	TFwarbler	1.49E-02	
Estimated Canada Warbler Conc	Bq/kg (FW)	Cwarbler	7.07E-03	=Itot*BW*TFwarbler

NB-93M INTAKE BY EASTERN-WHIP-POOR-WILL - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.053	
Water ingestion rate	L/d	Qwat	0.008	
Fresh weight food ingestion rate	g FW/d	Qffw	24.6	
Soil ingestion rate	g DW/d	Qsdw	0.00	
Fraction that is earthworms	-	few	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	0.0002934	Sitewide - 50% Perch Creek, 50% Ottawa River
Soil concentration	Bq/kg dw	Cs	285.3415	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to earthworm	kg/kg dw	TFew	0.95625	ERICA 2019
Earthworm moisture content	-	MCew	84.0%	U.S. EPA 1993
Earthworm concentration (DW)	Bq/kg dw	Cewdw	2.73E+02	=Cs*TFew
Earthworm concentration (FW)	Bq/kg fw	Cewfw	4.37E+01	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	Bq/kg-d	Iw	4.43E-05	=Qwat*Cw*Floc/BW
Intake from soil	Bq/kg-d	Is	0.00E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from earthworm	Bq/kg-d	Iew	2.03E+01	=Qffw*few*Cewfw*1kg/1000g*Floc/BW
Total intake	Bq/kg-d	Itot	2.03E+01	=Iw+Is+Iew
Estimated Concentration of Eastern-whip-poor-will				
Feed to Eastern-whip-poor-will TF	d/kg (FW)	TFewpw	4.57E-03	
Estimated Eastern-whip-poor-will Conc	Bq/kg (FW)	Cewpw	4.91E-03	=Itot*BW*TFewpw

NB-93M INTAKE BY SHORT-TAILED SHREW - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.015	
Water ingestion rate	L/d	Qwat	0.00226	
Fresh weight food ingestion rate	g FW/d	Qffw	9	
Soil ingestion rate	g DW/d	Qsdw	0.19	
Fraction that is earthworms	-	few	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	5.86E-04	Perch Creek
Soil concentration	Bq/kg dw	Cs	2.85E+02	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to earthworm	kg/kg dw	TFew	0.95625	ERICA 2019
Earthworm moisture content	-	MCew	84.0%	U.S. EPA 1993
Earthworm concentration (DW)	Bq/kg dw	Cewdw	272.9	=Cs*TFew
Earthworm concentration (FW)	Bq/kg fw	Cewfw	43.66	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	Bq/kg-d	Iw	8.83E-05	=Qwat*Cw*Floc/BW
Intake from soil	Bq/kg-d	Is	3.56E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from earthworm	Bq/kg-d	Iew	2.62E+01	=Qffw*few*Cewfw*1kg/1000g*Floc/BW
Total intake	Bq/kg-d	Itot	2.98E+01	=Iw+Is+Iew
Estimated Concentration of Short-tailed Shrew				
Feed to Short-tailed Shrew TF	d/kg (FW)	TFshrew	7.35E-04	
Estimated Short-tailed Shrew Conc	Bq/kg (FW)	Cshrew	3.28E-04	=Itot*BW*TFshrew

NB-93M INTAKE BY MEADOW VOLE - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.0349	
Water ingestion rate	L/d	Qwat	0.007	
Fresh weight food ingestion rate	g FW/d	Qffw	11.517	
Soil ingestion rate	g DW/d	Qsdw	0.08	
Fraction that is terr. vegetation	-	ftv	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	5.86E-04	Perch Creek
Soil concentration	Bq/kg dw	Cs	2.85E+02	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to Terrestrial Vegetation	kg/kg dw	TFtv	0.029	CSA 2018 Table G.3
Terr Veg moisture content	-	MCtv	80.0%	CSA 2017, Table G.5
Terr Veg concentration (DW)	Bq/kg dw	Ctvdw	8.27E+00	=Cs*TFew
Terr Veg concentration (FW)	Bq/kg fw	Ctvfw	1.65E+00	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	Bq/kg-d	Iw	1.18E-04	=Qwat*Cw*Floc/BW
Intake from soil	Bq/kg-d	Is	6.78E-01	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from terr. Vegetation	Bq/kg-d	Itv	5.46E-01	=Qffw*ftv*Ctvfw*1kg/1000g*Floc/BW
Total intake	Bq/kg-d	Itot	1.22E+00	=Iw+Is+Itv
Estimated Concentration of Meadow Vole				
Feed to Meadow Vole TF	d/kg (FW)	TFvole	3.90E-04	
Estimated Meadow Vole Conc	Bq/kg (FW)	Cvole	1.67E-05	=Itot*BW*TFvole

SAMPLE CALCULATIONS FOR NON-RADIOLOGICAL DOSES

Normal Evolution Scenario

LEAD INTAKE BY BALD EAGLE - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	4.7	
Water ingestion rate	L/d	Qwat	0.188	
Fresh weight food ingestion rate	g FW/d	Qffw	564	
Soil ingestion rate	g DW/d	Qsdw	5.91	
Fraction that is fish	-	ffi	0.65	
Fraction that is birds	-	fbd	0.15	
Fraction that is small mammals	-	fsm	0.20	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	5.71E-03	Sitewide - 50% Perch Creek, 50% Ottawa River
Soil concentration	mg/kg dw	Cs	5.90E+01	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Water to fish (Whole)	L/kg (fw)	TFfish	370	IAEA 2010 Table 57
Whole fish concentration (FW)	mg/kg fw	Cfishfw	2.11E+00	=Cw*TFfish
Bird concentration (FW)	mg/kg fw	Cbirdsfw	1.10E+00	average of Purple Finch, Canada Warbler and Eastern-whip-poor-will (see calculations below)
Small Mammal concentration (FW)	mg/kg fw	Csmfw	6.17E-02	average of short-tailed shrew and meadow vole (see calculations below)
Calculation of Intakes				
Intake from water	mg/kg-d	Iw	2.28E-04	=Qwat*Cw*Floc/BW
Intake from soil	mg/kg-d	Is	7.42E-02	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from fish	mg/kg-d	Ifi	1.65E-01	=Qffw*ffi*Cfishfw*1kg/1000g*Floc/BW
Intake from birds	mg/kg-d	Ibirds	1.98E-02	=Qffw*fbd*Cbirdsfw*1kg/1000g*Floc/BW
Intake from small mammals	mg/kg-d	Ism	1.48E-03	=Qffw*fsm*Csmfw*1kg/1000g*Floc/BW
Total intake	mg/kg-d	Itot	2.60E-01	=Iw+Is+Ifi+Ibirds+Ism
TRV	mg/kg-d	TRV	11.3	For terrestrial bird
SI	-		2.30E-02	=Itot / TRV

Normal Evolution Scenario

LEAD INTAKE BY PURPLE FINCH - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.024	
Water ingestion rate	L/d	Qwat	0.005	
Fresh weight food ingestion rate	g FW/d	Qffw	5.6	
Soil ingestion rate	g DW/d	Qsdw	0.47	
Fraction that is seeds	-	fseed	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	8.42E-03	Perch Creek
Soil concentration	mg/kg dw	Cs	5.90E+01	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to seeds	kg/kg dw	TFseeds	0.0053	IAEA 2010 Table 17 (seeds and pods of Leguminous vegetables)
Seeds moisture content	-	MCseeds	9.3%	U.S. EPA 1993
Seeds concentration (DW)	mg/kg dw	Cseedsdw	3.13E-01	=Cs*TFseeds
Seeds concentration (FW)	mg/kg fw	Cseedsfw	2.84E-01	=Cseedsdw*(1-MCseeds)
Calculation of Intakes				
Intake from water	mg/kg-d	Iw	1.75E-03	=Qwat*Cw*Floc/BW
Intake from soil	mg/kg-d	Is	1.17E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from seeds	mg/kg-d	Iseed	6.64E-02	=Qffw*fseed*Cseedsfw*1kg/1000g*Floc/BW
Total intake	mg/kg-d	Itot	1.23E+00	=Iw+Is+Iseed
Estimated Concentration of Purple Finch				
Feed to Purple Finch TF	d/kg (FW)	TFfinch	2.21E+01	
Estimated Purple Finch Conc	mg/kg (FW)	Cfinch	6.53E-01	=Itot*BW*TFfinch

LEAD INTAKE BY CANADA WARBLER - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.011	
Water ingestion rate	L/d	Qwat	0.003	
Fresh weight food ingestion rate	g FW/d	Qffw	8.8	
Soil ingestion rate	g DW/d	Qsdw	0.32	
Fraction that is earthworms	-	few	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	8.42E-03	Perch Creek
Soil concentration	mg/kg dw	Cs	5.90E+01	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to earthworm	kg/kg dw	TFew	0.31	Sample et al. 1998, Table 11, geomean
Earthworm moisture content	-	MCew	84.0%	U.S. EPA 1993
Earthworm concentration (DW)	mg/kg dw	Cewdw	1.83E+01	=Cs*TFew
Earthworm concentration (FW)	mg/kg fw	Cewfw	2.93E+00	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	mg/kg-d	Iw	2.30E-03	=Qwat*Cw*Floc/BW
Intake from soil	mg/kg-d	Is	1.73E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from earthworm	mg/kg-d	Iew	2.34E+00	=Qffw*few*Cewfw*1kg/1000g*Floc/BW
Total intake	mg/kg-d	Itot	4.07E+00	=Iw+Is+Iew
Estimated Concentration of Canada Warbler				
Feed to Canada Warbler TF	d/kg (FW)	TFwarbler	3.96E+01	
Estimated Canada Warbler Conc	mg/kg (FW)	Cwarbler	1.77E+00	=Itot*BW*TFwarbler

LEAD INTAKE BY EASTERN-WHIP-POOR-WILL - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.053	
Water ingestion rate	L/d	Qwat	0.008	
Fresh weight food ingestion rate	g FW/d	Qffw	24.6	
Soil ingestion rate	g DW/d	Qsdw	0.00	
Fraction that is earthworms	-	few	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	5.71E-03	Sitewide - 50% Perch Creek, 50% Ottawa River
Soil concentration	mg/kg dw	Cs	5.90E+01	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to earthworm	kg/kg dw	TFew	0.31	Sample et al. 1998, Table 11, geomean
Earthworm moisture content	-	MCew	84.0%	U.S. EPA 1993
Earthworm concentration (DW)	mg/kg dw	Cewdw	1.83E+01	=Cs*TFew
Earthworm concentration (FW)	mg/kg fw	Cewfw	2.93E+00	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	mg/kg-d	Iw	8.62E-04	=Qwat*Cw*Floc/BW
Intake from soil	mg/kg-d	Is	0.00E+00	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from earthworm	mg/kg-d	Iew	1.36E+00	=Qffw*few*Cewfw*1kg/1000g*Floc/BW
Total intake	mg/kg-d	Itot	1.36E+00	=Iw+Is+Iew
Estimated Concentration of Eastern-whip-poor-will				
Feed to Eastern-whip-poor-will TF	d/kg (FW)	TFewpw	1.22E+01	
Estimated Eastern-whip-poor-will Con	mg/kg (FW)	Cewpw	8.77E-01	=Itot*BW*TFewpw

LEAD INTAKE BY SHORT-TAILED SHREW - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.015	
Water ingestion rate	L/d	Qwat	0.00226	
Fresh weight food ingestion rate	g FW/d	Qffw	9	
Soil ingestion rate	g DW/d	Qsdw	0.19	
Fraction that is earthworms	-	few	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	8.42E-03	Perch Creek
Soil concentration	mg/kg dw	Cs	5.90E+01	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to earthworm	kg/kg dw	TFew	0.31	Sample et al. 1998, Table 11, geomean
Earthworm moisture content	-	MCew	84.0%	U.S. EPA 1993
Earthworm concentration (DW)	mg/kg dw	Cewdw	18.3	=Cs*TFew
Earthworm concentration (FW)	mg/kg fw	Cewfw	2.93	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	mg/kg-d	Iw	1.27E-03	=Qwat*Cw*Floc/BW
Intake from soil	mg/kg-d	Is	7.35E-01	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from earthworm	mg/kg-d	Iew	1.76E+00	=Qffw*few*Cewfw*1kg/1000g*Floc/BW
Total intake	mg/kg-d	Itot	2.49E+00	=Iw+Is+Iew
Estimated Concentration of Short-tailed Shrew				
Feed to Short-tailed Shrew TF	d/kg (FW)	TFshrew	1.98E+00	
Estimated Short-tailed Shrew Conc	mg/kg (FW)	Cshrew	7.40E-02	=Itot*BW*TFshrew

LEAD INTAKE BY MEADOW VOLE - SITEWIDE

Receptor Characteristics				
Body weight	kg	BW	0.0349	
Water ingestion rate	L/d	Qwat	0.007	
Fresh weight food ingestion rate	g FW/d	Qffw	11.517	
Soil ingestion rate	g DW/d	Qsdw	0.08	
Fraction that is terr. vegetation	-	ftv	1.00	
Fraction of time at site	-	Floc	1.00	
Measured Concentrations				
Surface water concentration	mg/L	Cw	8.42E-03	Perch Creek
Soil concentration	mg/kg dw	Cs	5.90E+01	Sitewide - 50% Garden, 50% Grazing Area
Estimated Concentrations				
TF - Soil to Terrestrial Vegetation	kg/kg dw	TFtv	0.31	IAEA 2010 Table 17 (Grasses)
Terr Veg moisture content	-	MCtv	80.0%	CSA 2018, Table G.5
Terr Veg concentration (DW)	mg/kg dw	Ctvdw	1.83E+01	=Cs*TFew
Terr Veg concentration (FW)	mg/kg fw	Ctvfw	3.66E+00	=Cewdw*(1-MCew)
Calculation of Intakes				
Intake from water	mg/kg-d	Iw	1.69E-03	=Qwat*Cw*Floc/BW
Intake from soil	mg/kg-d	Is	1.40E-01	=Qsdw*Cs*1kg/1000g*Floc/BW
Intake from terr. Vegetation	mg/kg-d	Itv	1.21E+00	=Qffw*ftv*Ctvfw*1kg/1000g*Floc/BW
Total intake	mg/kg-d	Itot	1.35E+00	=Iw+Is+Itv
Estimated Concentration of Meadow Vole				
Feed to Meadow Vole TF	d/kg (FW)	TFvole	1.05E+00	
Estimated Meadow Vole Conc	mg/kg (FW)	Cvole	4.95E-02	=Itot*BW*TFvole

APPENDIX C

Blanding's Turtle

APPENDIX C: BLANDING'S TURTLE

Blanding's turtles have been confirmed to inhabit and have been the subject of field studies on the CRL site since 2009. Critical habitat for Blanding's turtles was partially defined in the draft recovery strategy (ECCC 2018), and this definition was applied to the CNL baseline data for this VC. Utilizing the ECCC definition, a portion of the NSDF footprint includes critical habitat for the Blanding's Turtle (NSDF EIS). Blanding's turtle is thus an important species for the CRL site and furthermore has 'threatened' status under the *Species At Risk Act (SARA).* For these reasons a radiological assessment of Blanding's turtle was completed and included in this appendix. Due to a lack of sufficient information (e.g., transfer factors), a quantitative assessment of risks from non-radiological exposure resulting from aluminum, copper, lead or uranium was not possible.

Blanding's turtle is a freshwater reptile that typically prefers plant-filled shallow waters, such as lake, ponds, wetlands and slow-moving streams, although in winter, it sometimes move to deeper waters (RCGS 2014). In order to assess exposure from aquatic sources in the ecological risk assessment (EcoRA) for the NSDF site, Blanding's turtle was assumed to occur either on the Ottawa River (Receptor 1) or Perch Creek (Receptor 2). Given its smaller home range, exposure to Blanding's turtle was assumed to be localized to either the river or the creek. Receptor 1 was assumed to receive 100% of their exposure from the ingestion of surface water, sediment, aquatic vegetation, benthic invertebrates or fish from the Ottawa River and Receptor 2 was assumed to receive 100% of their exposure from the ingestion surface water, sediment, aquatic vegetation, benthic invertebrates or fish from Perch Creek (see Table C-1).

Table C-1 Blanding's Turtle Localized Exposure Areas at the NSDF Site and Exposure Assumptions

AQUATIC ENVIRONMENT	Blanding's Turtle
Ottawa River near NSDF Site	**Receptor 1**
Surface Water	√ (1) [100%]
Sediment	√ (1) [100%]
Aquatic Vegetation	√ (1) [100%]
Benthic Invertebrates & Insects	√ (1) [100%]
Fish (Pelagic or Benthic)	√ (1) [100%]
Perch Creek	**Receptor 2**
Surface Water	√ (2) [100%]
Sediment	√ (2) [100%]
Aquatic Vegetation	√ (2) [100%]
Benthic Invertebrates & Insects	√ (2) [100%]
Fish (Pelagic or Benthic)	√ (2) [100%]

An ecological profile presented below in Table C-2 was developed for Blanding's turtle outlining receptor characteristics (exposure factors) including body weight, dietary composition, food and water ingestion rates that were used to calculate radiological doses. The table also outlines assumptions that were made and cites sources that were used to obtain the information. It was conservatively assumed that the turtle spends the entire exposure duration within its localized exposure area (i.e., Ottawa River or Perch Creek). In other words, there is was no reduction to account for time spent outside of the exposure location or for time spent hibernating during the winter. It should be noted that Blanding's Turtles at CRL site have primarily been cited in swamps but the EcoRA assesses its presence in Perch Creek and Ottawa River. The modelled habitat versus observed occupancy in swamps leads to some uncertainty in the calculations. However, only Perch Lake Swamp is between NSDF and Perch Creek. Also there is a significant safety margin in the dose calculations so that the impact to exposure in Perch Swamp would still have similar conclusions.

Table C-2 Blanding's Turtle (*Emydoidea blandingii*) Characteristics

Parameter Description	Calculated from		Units	Value	Reference	Notes
Body weight			kg	1.3	RCGS (2014)	Average of body weight for Blanding's Turtle.
Water ingestion rate	0.02	g/g wet BW/d	g/d	26	U.S. EPA (1993b)	In the absence of a water ingestion rate for Blanding's Turtle, the water ingestion rate for the Midland Painted Turtle (representing pond and marsh turtles) was assumed for this species.
Food ingestion rate			g dw/d g ww/d	7.89 39.5	U.S. EPA (1993)	Based on the allometric equation provided in U.S. EPA (1993) for reptiles and amphibians. It should be noted that the developed allometric equation is for iguanid lizards, which is the only information of this type that has been identified for any amphibian or reptile. An average 80% moisture content was assumed for food items.
Fraction of food that is fish	-	-	-	0.4	Assumed	These species are omnivores and they usually feed on insects, leeches, snails, small fish, frogs, and occasionally some plants (Kipp 2000).
Fraction of food that is benthic	-	-	-	0.4	Assumed	
Fraction of food that is aquatic vegetation	-	-	-	0.2	Assumed	
Sediment ingestion rate	-	-	-	NA	-	Negligible.
Inhalation rate	-	-	-	-	-	-
Fraction of time at site	-	-	-	1	-	Assumed home range within site.

Notes (Kipp 2000; RCGS 2014; Grgurovic and Sievert 2005)**:**

- **Trophic level or ecosystem role (e.g., predator or prey):** Mid trophic level; prey, omnivore.
- **Life history:** Blanding's turtle is one of the longest-lived turtles in the world with an average lifespan of more than 70 years.
- **Importance to humans:** Protected under the *Species at Risk Act* due to 'threatened' status.
- **Habitat:** A medium-sized turtle (18-25 cm) which lives in shallow water, usually in large wetlands and shallow lakes with lots of water plants.
- **Home range size:** Mean annual home range was cited as 22 ha (0.22 km^2) by Grgurovic and Sievert (2005).
- **Important population dynamics:** It is found in groups on logs, grass clumps, sloping banks, or high perches near the water logs. They usually hibernate from late October until mid-April.

The PostSA (Arcadis and Quintessa 2019) assessed number of different scenarios for the NSDF project that included a Normal Evolution Scenario with several sensitivity analyses, Disruptive Events, Defence-in-depth and 'What-if' scenarios, as well as scenarios examining dose optimization. The PostSA predicted radionuclide concentrations in environmental media associated with each scenario and the maximum predicated incremental concentrations over the 10,000-year post-closure period were used to calculate radiological doses to Blanding's Turtle. The radiological exposure point concentrations for surface water and sediment are presented in Table 3-2 of the main report and in Table 3-3 for benthic invertebrates, aquatic vegetation and fish.

Ecological risks were assessed by calculating screening index (SI) values, comparing the estimated exposure to the radiation benchmark. The SI measurement endpoint is at the population level. As a result, when the chosen benchmark encompasses long-term effects based on survival (mortality), growth, or reproduction, then the measurement endpoint is closely linked to the assessment endpoint (healthy populations) and the necessary inferences can be made (i.e., one can infer the 'healthiness' of the population). So, where an estimated exposure level is less than the corresponding benchmark (i.e., SI less than 1), effects on a population of biota are not expected; however, where an estimated exposure level is greater than the corresponding benchmark (i.e., SI greater than 1), deleterious effects on the biota population may or may not occur and further study may be required to determine potential effects. The assessment of species at risk is different in that these species are assessed at the individual rather than the population level. The SI is calculated in the same way but the benchmarks are adjusted to be protective at the individual level.

The radiation benchmark of 9.6 mGy/d for aquatic biota was taken from UNSCEAR (2008) and adjusted by a factor of 10 (0.96 mGy/d) to account for the fact that Blanding's turtle is a species at risk requiring assessment at the individual rather than the population level. This is consistent with CSA N288.6-12 (CSA 2012) recommendations for radiological benchmarks.

The SI values that were calculated for Blanding's turtle in the Ottawa River and Perch Creek for each PostSA scenario are summarized in Table C-3. As seen from Table C-3, there were no exceedances of the SI benchmark value of 1 for Blanding's turtle in either the Ottawa River or Perch Creek for any of the PostSA scenarios assessed. The highest SI value was 0.068 calculated for the Ottawa River in scenario (15). Furthermore, these results have a large safety margin given the very conservative assumptions that were used in the EcoRA. For example, the Blanding's turtle was assumed to spend all of its time in the local exposure area, consuming all of its food and water from the local exposure area. Another conservative assumption was the use of maximum radionuclide concentrations.

Table C-3 Radiological Risk Screening Index Values for Blanding's Turtle

PostSA Scenario	Blanding's Turtle *	
	Ottawa River (Receptor 1)	Perch Creek (Receptor 2)
Benchmark (mGy/d)	0.96	0.96
(1) Normal Evolution Scenario (NES) & (9) Dose Optimization - Confidence in Land Use Restrictions		
Total Dose (mGy/d)	3.69E-11	2.07E-07
SI (-)	3.84E-11	2.16E-07
(1a) NES Sensitivity Analysis: Inventory Sensitivity		
Total Dose (mGy/d)	1.33E-05	1.07E-02
SI (-)	1.38E-05	1.12E-02
(1b) NES Sensitivity Analysis: Institutional Control Sensitivity		
Total Dose (mGy/d)	3.69E-11	2.07E-07
SI (-)	3.84E-11	2.16E-07
(1c) NES Sensitivity Analysis: Sorption Coefficient Sensitivity		
Total Dose (mGy/d)	8.16E-06	6.35E-03
SI (-)	8.50E-06	6.61E-03
(1d) NES Sensitivity Analysis: Geosphere – Rapid Transit to Perch Creek		
Total Dose (mGy/d)	3.75E-11	2.10E-07
SI (-)	3.90E-11	2.18E-07
(1e) NES Sensitivity Analysis: Enhanced Degradation of Cover and Liner		
Total Dose (mGy/d)	2.99E-11	1.69E-07
SI (-)	3.12E-11	1.76E-07
(1f) NES Sensitivity Analysis: Global Warming – Reduced HER		
Total Dose (mGy/d)	2.98E-11	1.71E-07
SI (-)	3.10E-11	1.78E-07
(3) Disruptive Event: Human Intrusion, House with Basement – Resident (Chronic)		
Total Dose (mGy/d)	3.69E-11	2.07E-07
SI (-)	3.84E-11	2.16E-07
(4) Disruptive Event: Enhanced Corrosion Case		
Total Dose (mGy/d)	2.10E-10	1.91E-07
SI (-)	2.19E-10	1.99E-07
(5) Disruptive Event: Localized Cover Failure		
Total Dose (mGy/d)	4.00E-11	2.19E-07
SI (-)	4.16E-11	2.29E-07
(6) Disruptive Event: Localized Liner Failure		
Total Dose (mGy/d)	1.11E-10	7.39E-07
SI (-)	1.15E-10	7.70E-07
(7) Disruptive Event: Damage to Berm		
Total Dose (mGy/d)	3.96E-11	2.15E-07
SI (-)	4.13E-11	2.24E-07
(8) Dose Optimization: Wastes Grouted into Steel Liners		
Total Dose (mGy/d)	3.69E-11	2.07E-07
SI (-)	3.84E-11	2.16E-07
(11) Defence-in-Depth: Role of Geosphere		
Total Dose (mGy/d)	6.27E-11	1.91E-06
SI (-)	6.53E-11	1.99E-06
(12) Defence-in-Depth: Role of Cover		
Total Dose (mGy/d)	5.43E-11	3.00E-07
SI (-)	5.65E-11	3.13E-07

PostSA Scenario	Blanding's Turtle *	
	Ottawa River (Receptor 1)	Perch Creek (Receptor 2)
Benchmark (mGy/d)	0.96	0.96
(13) Defence-in-Depth: Role of Base Liner		
Total Dose (mGy/d)	1.28E-10	7.93E-07
SI (-)	1.34E-10	8.26E-07
(14) Defence-in-Depth: Series of Landslides		
Total Dose (mGy/d)	1.07E-09	2.87E-07
SI (-)	1.11E-09	2.99E-07
(15) "What-If": Human Intrusion, Mass Excavation and Farming		
Total Dose (mGy/d)	8.44E-05	6.53E-02
SI (-)	8.79E-05	6.80E-02
(17) "What-If": Permanent Bathtub		
Total Dose (mGy/d)	9.17E-11	4.20E-07
SI (-)	9.55E-11	4.37E-07

Conclusion

There were no residual effects to Blanding's turtle resulting from exposure to radiation during the post-closure phase of the NSDF Project. Non-radiological risks were not quantified due to a lack of sufficient information.

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