REPORT

Soil Quality Remediation Objectives

Closure and Reclamation Plan, Meadowbank Complex

Submitted to:

Agnico Eagle Mines Limited

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1 DEVELOPMENT OF SOIL QUALITY REMEDIATION OBJECTIVES

Soil quality remediation objectives (SQROs) for the Site were developed based on the relevant receptors and exposure pathways evaluated in the Closure and Reclamation Plan (CRP) Human Health and Ecological Risk Assessment (HHERA) and the Meadowbank Complex Wildlife and Human Health Risk Assessment Country Foods Screening Level Risk Assessment Plan (WCFSLRA Plan; Agnico Eagle 2024). The SQROs will be used to support closure activities to identify areas of the mine requiring soil remediation.

In general, assumptions and approaches used in the SQRO development were adopted from the WCFSLRA Plan, unless more recent guidance was available. Pathway-specific SQROs were developed considering all human health pathways and all ecological pathways. SQROs protective of both human health and the environment were derived for the Site as the lower of the human health-based SQROs and the ecological-based SQROs. However, the SQROs were not set below the background soil concentration (e.g., maximum background [baseline] soil concentrations described in Section 4.1 of the CRP HHERA) or more stringent than the generic soil quality guidelines (i.e., Canadian Council of Ministers of the Environment [CCME] Soil Quality Guidelines [SQGs] for the Protection of Environmental and Human Health; CCME 2024). The SQROs for the Site are described in Section 4 and represent acceptable levels of risk to human health and the environment.

To focus the SQROs on the relevant pathways for Post-Closure of the mine, conceptual site models (CSMs) were developed based on the pathways listed below for human health (Figure 1-1) and ecological health (Figure 1-2).

The SQROs protective of each of the human health exposure pathways are presented in Table 2.1 and the assumptions and equations used to derive the SQROs are discussed in Section 2. Human health-based SQROs were developed to be protective of a member of the public from the following exposure pathways that may result in exposure to parameters of potential concern (POPCs) at the Meadowbank Complex during Post-Closure:

- direct contact with soil (including incidental ingestion, dermal contact, and particulate inhalation);
- consumption of berries that have accumulated POPCs from soil; and,
- consumption of wild game (represented by caribou meat, caribou organs, and goose meat) that have accumulated POPCs from soil.

The SQROs protective of each of the ecological exposure pathways are presented in Table 3.1 and the assumptions and equations used to derive the SQROs are discussed in Section 3. Ecological health-based SQROs were developed to be protective of ecological receptors from the following exposure pathways that may result in exposure to POPCs at the Meadowbank Complex during Post-Closure:

- direct contact with soil by terrestrial plants and soil invertebrates;
- incidental ingestion of soil and ingestion of plants (represented by berries, lichen and sedges) and prey (represented by insects) that have accumulated POPCs from soil and exposure by mammals and birds.

The list of POPCs for which SQROs were developed included the metals assessed in the WCFSLRA Plan (Agnico Eagle 2024) and the spill contaminants identified in the Phase Two Environmental Site Assessments (WSP 2024a,b). These included the following POPCs:

- Trichloroethylene
- Petroleum hydrocarbon fraction F2 (PHC F2)
- Methanol
- Cyanide
- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Cobalt
- Copper
- Lead
- Manganese
- Mercury (inorganic)
- Methylmercury
- Molybdenum
- Nickel
- Selenium
- Strontium
- Thallium
- Tin
- Uranium
- Vanadium
- Zinc

2 HUMAN HEALTH-BASED SOIL QUALITY REMEDIATION OBJECTIVES

Pathway-specific human health-based SQROs were developed for each of the relevant exposure human health pathways at the Meadowbank Complex during Post-Closure. For some constituents, a threshold level exists below which no adverse effects are anticipated to occur (i.e., threshold POPCs). In contrast, non-threshold constituents are considered to have some potential for risk of adverse effects at any level of exposure (i.e., non-threshold POPCs). For those POPCs that exhibit both threshold and non-threshold health effects, SQROs were developed considering both mechanisms of action. The overall human health SQRO was selected as the lowest of all exposure pathways and considering both threshold and non-threshold effects, if applicable (Table 2.1).

2.1 Exposure Assessment

2.1.1 Receptor Characteristics

For estimating threshold health risks for the member of the public, the toddler life stage was evaluated. Toddlers are considered more susceptible to threshold health effects from chemical exposures relative to adults because they typically have a greater intake rate to body weight ratio and certain behavioural activities may expose them to larger quantities of chemicals (e.g., playing in soil). In addition, some chemicals have been shown to be more toxic to toddlers than adults. Consistent with human health risk assessment (HHRA) guidance (Health Canada 2021a), the toddler (i.e., seven months to four years inclusive) was chosen as the most sensitive life stage for the assessment of threshold POPCs. A female adult of childbearing age was also considered because some of the POPCs (i.e., trichloroethylene, lead, methylmercury and vanadium) are considered developmental toxicants. For the assessment of exposure and risks due to non-threshold effects of POPCs, the adult receptor was evaluated.

The receptor characteristics used in the development of the human health-based SQROs are presented in Table 2.2. General receptor characteristics were based on Health Canada (2021a) (e.g., inhalation rates, soil ingestion rates, skin surface areas, soil loadings) and the WCFSLRA Plan (Agnico Eagle 2024) (e.g., wild game ingestion rates, body weights). The WCFSLRA Plan developed regional consumption rates for caribou meat, caribou organs and goose meat based on a heavy, moderate, and low scenario. The moderate consumption rate scenario was considered in the development of the SQROs. Receptor characteristics that were not specifically provided in the WCFSLRA Plan (Agnico Eagle 2024) or Health Canada (2021a) were adopted from other literature sources, including:

- Ingestion rate of berries was obtained from the Kuhnlein et al. (2000) study of Inuit communities and represent geomean values (0.0064 kg wet weight/day for toddler and 0.0018 kg wet weight/day for adult). This source was used in the HHRA for the Environmental Impact Statement for the Kiggavik Project in Nunavut and was considered to be relevant for this assessment.

2.1.2 Exposure Frequency and Duration

The exposure frequencies and durations were selected based on professional judgement and information provided in the WCFSLRA Plan (Agnico Eagle 2024) and are presented in Table 2.3.

The member of the public was assumed to live off-Site but would visit the Site to hunt and harvest traditional foods. There are no identified discrete receptor locations in the vicinity of Meadowbank Mine. There are grave sites and fishing locations in the vicinity of Whale Tail Mine that have been identified as discrete receptor locations in the HHERA (Section 5.1 of the HHERA); however, people are unlikely to stop at these discrete receptor locations for extended periods of time for the following reasons:

- There are no known permanent residences or cabins near the Site.
- People are not travelling to the areas surrounding the mine site for harvesting, but rather are fishing and harvesting berries closer to the community.
- The winter road to Garry Lake, Back River and Gjoa Haven is mainly used as a travel route to other destinations.

Given the distance from the community and the main travel routes, and the rough terrain in the area around the mine, it is unlikely that people would be at the discrete receptor locations daily on a long-term (chronic) basis. To allow a conservative assessment of exposure, it was assumed that members of the public may visit the area seasonally in the summer months (e.g., when exposure to Site media would be expected to be the highest) for up to 14 days per year during extended hunting trips in the area. It was assumed that toddlers and children would not be a part of the extended hunting trips given the remote location and that rough terrain would not be suitable for family hunting trips.

Although food items may only be available during certain times of the year, it was assumed that harvested food items are preserved (e.g., frozen or smoked) and stored for consumption at home.

Based on the moderate consumption rate scenario presented in the WCFSLRA Plan (Agnico Eagle 2024), caribou meat may be consumed three days per week for 52 weeks per year, caribou organs two days per month for 12 months per year, and goose meat for one meal per week for 52 weeks per year. However, a consumption of caribou organs for one day per week was also considered.

Berries were conservatively assumed to be consumed every day.

Exposure amortization represents the averaging of hours exposed to a chemical divided by 24 hours per day, days exposed to a chemical divided by seven days per week, and weeks per year exposed over 52 weeks per year. Health Canada (2021a) states that for threshold exposures, such averaging must be done only if chemical-specific rationale is provided to support that it will not underestimate potential risks. Exposure amortization is not considered for the evaluation of the female adult of childbearing age from exposure to developmental toxicants (i.e., trichloroethylene, lead, methylmercury, and vanadium) as it is possible that the effects can occur following a single or short exposure duration during specific developmental stages. For other threshold POPCs, the toxicokinetics of the chemical must be considered, such as the whole-body elimination half-life, to ensure that the chemical does not result in a persistent body burden where exposure may occur even when not on a site or when not consuming food items. As an initial assessment, Health Canada (2021a) therefore recommends that potential threshold risks first be evaluated without any exposure amortization. An exposure term of 1 was assumed for the development of the SQROs; however, where SQROs were deemed to be unreasonably low, a more detailed assessment was considered.

2.1.3 Relative Absorption Factors

Relative absorption factors (RAFs) represent the fraction of the constituent that is absorbed relative to the fraction absorbed in the study used to derive the toxicity reference value (TRV). The oral and dermal RAFs were obtained from Health Canada (2021b) or from the Ontario Ministry of the Environment, Conservation and Parks (MECP; MOECC 2016). For lead, recent guidance from MECP (2024a) was considered. The oral RAFs are only applicable to soil exposures, therefore a RAF of 1 was used for the consumption of plants and wild game pathways. Inhalation exposures were assumed to have a RAF of 100% (Health Canada 2021b). The oral, dermal, and inhalation RAFs used in the development of the SQROs are presented in Table 2.4.

2.1.4 Petroleum Hydrocarbon - Sub-Fractionation

Petroleum Hydrocarbons (PHCs) are mixtures of both aliphatic (straight chain) and aromatic (ring structure) compounds called sub-fractions and are termed according to the number of carbons in the chain or ring. PHC fraction F2 is measured analytically by the laboratory; however, risk estimates for PHCs are determined through assessing the hazard from each sub-fraction. The concentration of each sub-fraction within the measured PHC fractions was predicted by applying general proportions provided by CCME (2008) and are presented in Table 2.5.

Only exposure to PHCs through direct soil contact was assessed. Uptake of PHCs into country food items was not assessed because there are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern. Most PHC are readily metabolized by vertebrates, modified into a more readily excretable form, and thus do not tend to accumulate in tissues (CCME 2008).

2.1.5 Predictive Concentration in Plants

Site-specific bioaccumulation factors (BAFs) were estimated using measured vegetation tissue (sedge, lichen, and berry) and soil data collected during monitoring studies for the mine using the following equation:

$$BAF = \frac{C_{vt}}{C_s}$$

Where:

BAF = site-specific bioaccumulation factor (milligram per kilograms (mg/kg) wet weight (ww))
C_{vt} = concentration in vegetation tissue (mg/kg ww)
C_s = concentration in soil (mg/kg dw)

Vegetation tissue samples including sedge, lichen, and berries were collected from the Project area in 2011, 2014, 2017 and 2021 and analysed for metal concentrations (Agnico Eagle 2011, 2015, 2018, 2022).

Site-specific BAFs were estimated for sedge, lichen, and berry tissue using co-located soil data for each POPC and sampling location. The co-located concentrations were included in the BAF calculation only when the vegetation tissue and soil concentrations were both detected values. Non-detected results were excluded from the BAF calculations. The resulting BAFs were plotted relative to soil on a log-log basis and linear regressions were calculated to determine if a significant relationship was present.

Sedge, lichen, and berry BAFs were selected according to the following hierarchy:

1) If the regression was significant (p<0.05) and the data fit the regression line (r^2>0.2 and based on visual examination), then the regression equation was retained for estimation of the BAF. For barium, cadmium, copper, mercury and zinc in berries and mercury in lichen and sedges, the data appeared to fit the regression line; however, no relationship was found when calculating the human health SQROs. In these cases, the median BAF was used for the human health SQROs.

2) If the regression was not significant or the data did not fit the regression line, the median BAF of the specific vegetation tissue type/soil pairings was selected as the BAF representative of the soil exposure concentrations.

3) If a median BAF could not be calculated (i.e., there were fewer than four samples with detected concentrations), then the maximum BAF for specific vegetation tissue type/soil pairings was selected.

4) If a site-specific BAF could not be calculated for a parameter, a literature BAF was adopted.

If a site-specific BAF could not be calculated, the concentration of POPCs in plants was predicted using literature-based uptake equations, BAFs or bioconcentration factors (BCFs) obtained from the following sources in order of preference:

- United States Environmental Protection Agency (US EPA). 2007. Guidance for Developing Ecological Soil Screening Levels (Eco-SSL). Soil to plant uptake equation for inorganics.
- US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. Uptake factors for above ground produce.
- Baes et al. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture. Soil to plant concentration factor.

- US EPA. 1999. Screening Level Ecological Risk Assessment Protocol. Appendix C - Soil to plant bioconcentration factor.

These literature uptake equations/BCFs relate soil concentrations to predicted concentrations in plant tissue on a dry weight basis. To maintain consistent units with human health food ingestion rates (provided only in wet weight), plant concentrations predicted using literature uptake equations/BCFs were converted to wet weight using average moisture content in samples collected from the Site (i.e., 49% moisture in sedges, 24% moisture in lichens and 85% moisture in berries).

The equation for estimating plant concentrations using literature uptake equations/BCFs is presented below.

Plant Concentration (mg/kg wet weight [ww]) =
Soil Concentration (mg/kg dw) x Uptake Equation/BCF x (1-% Moisture/100)

The uptake equations/BCFs and predicted plant concentrations based on the SQROs are presented in Table 2.6 (Berries), Table 2.7 (Lichens), and Table 2.8 (Sedges).

2.1.6 Predictive Concentration in Caribou

2.1.6.1 Meat

Caribou (meat) concentrations were estimated using the approach outlined in US EPA (2005) based on the estimated daily intake of POPCs through soil and plant ingestion using caribou-specific soil and food ingestion rates and beef transfer factors as presented below:

Caribou Meat Concentration (mg/kg ww) =

[Sedges Concentration (mg/kg ww) x Food Ingestion Rate (kg ww/day) x Beef Transfer Factor (day/kg)] +

[Lichens Concentration (mg/kg ww) x Food Ingestion Rate (kg ww/day) x Beef Transfer Factor (day/kg)] +

[Berries Concentration (mg/kg ww) x Food Ingestion Rate (kg ww/day) x Beef Transfer Factor (day/kg)] +

[Soil Concentration (mg/kg dw) x Soil Ingestion Rate (kg dw/day) x Beef Transfer Factor (day/kg)]

Where:

- Caribou were assumed to have a diet of 30% sedges, 65% lichens and 5% berries as outlined in the WCFSLRA Plan (Agnico Eagle 2024), and the plant concentrations were estimated based on site-specific BAFs as discussed in Section 2.1.5.
- The food ingestion rate was based on the allometric equation for herbivorous mammals from US EPA (1993), assuming a body weight of 75 kg as reported in Dauphine (1976), consistent with the WCFSLRA Plan (Agnico Eagle 2024). The calculated food ingestion rate was converted to wet food intake assuming 49% moisture in sedges, 24% moisture in lichens and 85% moisture content in berries, based on samples collected from the Site.

- The soil ingestion rate was assumed to be 5% of the dry food ingestion rate, which is the general rate for mammals provided in Beyer at al. (1994), consistent with the WCFSLRA Plan (Agnico Eagle 2024). The soil ingestion rate was converted to wet food intake assuming site specific moisture content of 35% for caribou diet (calculated from 30% sedges at 49% moisture, 65% lichens at 24% moisture, and 5% berries at 85% moisture).
- The beef transfer factor was obtained from the following sources in order of preference:
  - US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.
  - Baes et al. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture. Ingestion-to-beef transfer factor.

The caribou meat concentrations were also adjusted for the proportion of time assumed to be spent in the study area, estimated to be 12% based on the WCFSLRA Plan (Agnico Eagle 2024).

These parameters and the predicted moose meat concentrations based on the SQROs are presented in Table 2.9. The WCFSLRA Plan (Agnico Eagle 2024) notes that biotransfer factors may be updated using current literature, as available, at the time of future assessments. The sources of some assumptions for the biotransfer factors provided in the WCFSLRA Plan could not be confirmed, as such, the caribou biotransfer factors used in the development of the SQROs were selected from sources commonly used in HHRAs for environmental assessments.

2.1.6.2 Organs

Caribou organ (kidney and liver) concentrations were calculated from modelled caribou meat concentrations using organ-specific ratios. The ratios were calculated based on measured concentrations in caribou muscle, kidney and liver obtained from the First Nations Food, Nutrition and Environment Study (FNFNES) (University of Ottawa 2021), as presented in Table 2.10. While these ratios differ from the WCFSLRA Plan (Agnico Eagle 2024), this is considered to be a current source based on Canadian First Nation communities and is a commonly used approach in HHRAs for environmental assessments.

The predicted organ concentrations are presented in Table 2.9.

2.1.7 Predictive Concentration in Goose

Goose (meat) concentrations were estimated based on the estimated daily intake of POPCs through soil and plant ingestion using goose specific soil and food ingestion rates and goose transfer factors as presented below:

Goose Meat Concentration (mg/kg ww) =

[Plant Concentration (mg/kg ww) x Food Ingestion Rate (kg ww/day) x Poultry Transfer Factor (day/kg)] +

[Soil Concentration (mg/kg dw) x Soil Ingestion Rate (kg dw/day) x Poultry Transfer Factor (day/kg)]

Where:

- The Canada goose was assumed to have a diet of 50% sedges and 50% berries, and the plant concentrations were estimated based on site-specific BAFs as discussed in Section 2.1.5. Proportions in diet are consistent with the WCFSLRA Plan (Agnico Eagle 2024), except that 50% of the diet is assumed to be berries rather than 45% berries/ 5% insects. Insects were not assumed to be in the diet as US EPA (1993)

indicates that the Canada goose diet comprises of <1% insects and abundant insects are not expected in the Arctic climate.

- The food ingestion rate was based on empirical data from US EPA (1993), expressed as a wet food ingestion rate.
- The soil ingestion rate was assumed to be 8.2% of the dry food ingestion rate from US EPA (1993), where the wet food ingestion rate was converted to dry weight assuming 85% moisture content in berries and 49% moisture in grasses (a surrogate for sedges).
- The poultry transfer factor was obtained from the following sources in order of preference:
  - US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.
  - In absence of a poultry transfer factor, the beef transfer factor was applied.

The goose meat concentrations were also adjusted for the proportion of time assumed to be spent in the study area, estimated to be 33% based on the WCFSLRA Plan (Agnico Eagle 2024).

These parameters and the predicted goose meat concentrations based on the SQROs are presented in Table 2.11. The WCFSLRA Plan (Agnico Eagle 2024) notes that biotransfer factors may be updated using current literature, as available, at the time of future assessments. The sources of some assumptions for the biotransfer factors provided in the WCFSLRA Plan could not be confirmed, as such, the Canada goose biotransfer factors used in the development of the SQROs were selected from sources commonly used in HHRAs for environmental assessments.

2.1.8 Exposure Doses

Exposure doses (estimated daily intakes) were calculated according to the equations provided by Health Canada (2021a) and presented below. The exposure doses used in the development of the SQROs are presented in Table 2.12 (soil ingestion, dermal contact, inhalation) and Table 2.13 (consumption of berries, consumption of caribou meat and organs, consumption of goose meat).

2.1.8.1 Incidental Ingestion of Soil

$$\text{Dose (mg/kg-day)} = \frac{Cs \times SIR \times RAF_{Oral} \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

Cs = Soil concentration (mg/kg)
SIR = Soil ingestion rate (kg/day)
RAF_{Oral} = Relative absorption factor from the gastrointestinal tract (unitless)
D_2 = Days per week exposed/7 days
D_3 = Weeks per years exposed/52 weeks
BW = Body weight (kg)
D_4 = Years exposed (for non-threshold POPCs)
LE = Life expectancy (for non-threshold POPCs)

2.1.8.2 Dermal Contact with Soil

$$\text{Dose (mg/kg-day)} = \frac{[(Cs \times SA_H \times SL_H) + (Cs \times SA_O \times SL_O)] \times RAF_{Derm} \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

- Cs = Soil concentration (mg/kg)
- SA_H = Surface area of hands exposed for soil loading (square centimeter; cm^2)
- SA_O = Surface area exposed other than hands (cm^2)
- SL_H = Soil loading rate to exposed skin of hands (kg/cm^2-event)
- SL_O = Soil loading rate to exposed skin other than hands (kg/cm^2-event)
- RAF_{Derm} = Relative dermal absorption factor (unitless)
- D_2 = Days per week exposed/7 days
- D_3 = Weeks per years exposed/52 weeks
- BW = Body weight (kg)
- D_4 = Years exposed (for non-threshold POPCs)
- LE = Life expectancy (for non-threshold POPCs)

2.1.8.3 Inhalation of Soil Particulates (where TRV is expressed as a tolerable daily intake)

$$\text{Dose (mg/kg-day)} = \frac{Cs \times P_{air} \times IR_S \times RAF_{Inh} \times D_1 \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

- Cs = Soil concentration (mg/kg)
- P_{air} = Theoretical particulate concentration in air (7.6×10^{-10} kg/m^3 based on Health Canada (2021a))
- IR_s = Inhalation rate for soil (cubic meter (m^3)/day)
- RAF_{Inhal} = Relative absorption factor for inhalation (unitless)
- D_1 = Hours per day exposed/ 24 hours
- D_2 = Days per week exposed/7 days
- D_3 = Weeks per years exposed/52 weeks
- BW = Body weight (kg)
- D_4 = Years exposed (for non-threshold POPCs)
- LE = Life expectancy (for non-threshold POPCs)

This approach was used to calculate the SQRO.

2.1.8.4 *Inhalation of Soil Particulates (where TRV is expressed as a tolerable concentration)*

$$\text{Time-adjusted daily average air concentration (mg/m}^3\text{)} = \frac{Cs \times Pair \times RAF_{inh} \times D_1 \times D_2 \times D_3 \times D_4}{LE}$$

Where:

- Cs = Soil concentration (mg/kg)
- P_{air} = Particulate concentration in air (7.6×10^{-10} kg/m^3 based on Health Canada (2021a))
- RAF_{Inhal} = Relative absorption factor for inhalation (unitless)
- D_1 = Hours per day exposed/ 24 hours
- D_2 = Days per week exposed/7 days
- D_3 = Weeks per years exposed/52 weeks
- D_4 = Years exposed (for non-threshold POPCs)
- LE = Life expectancy (for non-threshold POPCs)

This approach was used to assess POPCs that exhibit non-threshold effects through inhalation exposures only (e.g., beryllium, cadmium, chromium [VI], nickel) to ensure that the SQRO calculated based on this exposure was not a risk driver (refer to Section 2.3.3 for further discussion).

2.1.8.5 *Food Ingestion*

$$\text{Dose (mg/kg-day)} = \frac{Cf \times FIR \times RAF_{Oral} \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

- Cf = Concentration in food item (mg/kg ww)
- FIR = Ingestion rate of food item (kg ww/d)
- RAF_{Oral} = Relative absorption factor from the gastrointestinal tract (unitless)
- D_2 = Days per week exposed/7 days
- D_3 = Weeks per years exposed/52 weeks
- BW = Body weight (kg)
- D_4 = Years exposed (for non-threshold POPCs)
- LE = Life expectancy (for non-threshold POPCs)

2.2 Toxicity Assessment

The toxicity assessment involved a review of toxicity information for each of the POPCs and included the selection of TRVs. The type of health effect (e.g., non-threshold vs. threshold) and the pathway by which a receptor is exposed to the constituent (e.g., ingestion, dermal contact, inhalation) were considered when selecting TRVs.

2.2.1 Chemical Classification

For threshold constituents, a threshold level exists below which no adverse effects are anticipated to occur. In contrast, non-threshold constituents are considered to have some potential for risk of adverse effects at any level of exposure. Several organizations have developed classification systems based on the properties of chemicals. The classification systems from Health Canada (2021b), US EPA (2024a) and the International Agency for Research on Cancer (IARC 2024) are presented in Table 2.14. The classifications for each POPC are presented

in Table 2.15. Trichloroethylene and arsenic are known to have non-threshold effects for both the oral and inhalation pathways. Beryllium, cadmium, and chromium (VI) have non-threshold effects for the inhalation pathway only.

2.2.2 Toxicity Reference Values

TRVs are based on critical effects observed from studies in exposed human populations or animal species. For threshold POPCs, the TRV is a reference dose or a reference concentration. The reference dose represents an estimated daily intake through ingestion to which people can be exposed to every day over a lifetime without experiencing a significant or adverse health impact. Reference doses are expressed as milligram per kilogram body weight per day. A reference concentration is an estimate of continuous inhalation exposure to a constituent by the human population (including sensitive subgroups) that is likely to be without an appreciable risk of adverse effects over a lifetime.

For non-threshold POPCs, the TRVs are slope factors for the oral pathway and inhalation unit risks for the inhalation pathway. A slope factor is the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a constituent at a concentration of 1 microgram per cubic metre ($\mu g/m^3$) in air.

The WCFSLRA Plan (Agnico Eagle 2024) states that TRVs will be reviewed and updated at the time of future assessments. As the current TRVs were last reviewed in 2017, the TRVs were updated for the development of the SQROs. TRVs were obtained preferentially from Health Canada (2021b) followed by Ontario MECP (2024b) and US EPA (2024a) and are protective of chronic health effects. In absence of a TRV for tin from any of these agencies, the Health Effects Assessment Summary Tables (HEAST 2019) was considered. The selected oral TRVs are presented in Table 2.16. For POPCs that exhibit a non-threshold effect only through the inhalation pathway, inhalation unit risks were considered as presented in Table 2.17.

As of the latest publication of TRVs (Health Canada 2021b), Health Canada has not derived a TRV for lead. Based on the available scientific literature, no threshold could be established for the identified critical effect for lead (neurodevelopmental toxicity). Therefore, it is recommended by Health Canada (2021b) that lead be considered a non-threshold substance. The risk-specific dose from the European Food Safety Authority (EFSA 2013) provided by Health Canada (2021b) was recommended as a provisional TRV and was used as the oral TRV for lead for the assessment of threshold effects.

2.3 Calculation of Human Health Soil Quality Remediation Objectives

In a risk assessment, risk characterization is the integration of the exposure and toxicity assessments when the exposures estimated for each of the receptors is compared to the identified TRVs to determine if site-related exposures have the potential to cause health effects, or whether these exposures are negligible. Because of the differences in the biological mechanisms of action between threshold and non-threshold chemicals, the potential hazards/risks are determined differently. For those POPCs which exhibit both threshold and non-threshold health effects, SQROs were developed considering both mechanisms of action. The overall human health SQRO was selected as the lowest of all exposure pathways and considering both threshold and non-threshold effects, if applicable (Table 2.1).

2.3.1 Threshold Parameters of Potential Concern

For constituents that exhibit a toxicity threshold (i.e., threshold POPCs), the risk estimate is expressed as a hazard quotient (HQ), which is calculated as the estimated exposure dose (Section 2.1) divided by the reference dose (or TRV) (Section 2.2), as follows:

$$HQ = \frac{\text{Estimated Exposure (mg/kg/day)}}{\text{TRV (Reference Dose) (mg/kg/day)}}$$

HQs are presented for the direct contact soil pathway (oral, dermal, soil inhalation), consumption of berries, consumption of caribou (meat and organs), and consumption of goose. Health Canada (2021a) indicates that if background exposure is not considered, a HQ of less than or equal to 0.2 is negligible for threshold POPC. This assumes that 20% of the "allowable" exposures are from the Site and 80% is from background sources not related to the Site. For PHCs, HQs of less than or equal to 0.5 is negligible (CCME 2008). Although lead is not a carcinogenic POPC, the TRV represents a non-threshold exposure level (i.e., a risk-specific dose), and therefore a target HQ of 1 was considered.

Therefore, the calculated SQRO for each exposure pathway was calculated as the soil concentration that results in a target HQ of 0.2 (0.5 for PHCs and 1 for lead). The SQROs were calculated using the "goal seek" function in Microsoft Excel which iteratively changes the input soil concentration in the equations used to calculate doses in and HQs for the pathways to obtain target. The SQROs for threshold effects are presented in Table 2.1.

2.3.2 Non-Threshold Parameters of Potential Concern

Non-threshold POPCs are generally considered to elicit health effects via a non-threshold mechanism. This means that there is no dose below which an adverse effect will not occur, and any exposure is associated with some level of risk. The probability of adverse effects is expressed as the incremental lifetime cancer risk (ILCR) and is calculated using the equation below:

$$ILCR = \text{Estimated Exposure (mg/kg/day)} \times \text{TRV (cancer slope factor in mg/kg/day}^{-1})$$

For each exposure pathway, Health Canada (2021a) considers an acceptable risk to be one-in-one hundred thousand ($1x10^{-5}$). Therefore, the calculated SQRO for each exposure pathway for non-threshold POPCs was calculated as the soil concentration that results in an ILCR of $1x10^{-5}$ as presented in Table 2.1.

2.3.3 Quantitative Assessment of Non-Threshold Risk from Inhalation

SQROs were also calculated for the POPCs that are exhibit non-threshold effects only through the inhalation pathway (i.e., beryllium, cadmium, chromium (VI) and nickel) to ensure that the human health SQRO is protective of this pathway. The ILCR for these POPCs was calculated using the equation below.

$$ILCR = \text{Estimated Exposure (mg/m}^3) \times \text{TRV (inhalation unit risk - mg/m}^{3\ -1})$$

The calculated SQRO for the inhalation pathway for non-threshold POPCs was calculated as the soil concentration that results in an ILCR of $1x10^{-5}$. The SQROs for non-threshold POPCs via the inhalation pathway are presented in Table 2.18. These SQROs are higher than those predicted for the direct soil contact pathway, which incorporated soil inhalation exposure based on oral TRVs. Therefore, these SQROs were not further considered.

2.4 Uncertainties

Numerous assumptions were made in the development of human health SQROs. The most significant assumptions and their implications on the SQROs are presented in Table 2.19. In general, the assumptions are conservative and overestimate risk.

Table 2.19: Uncertainties and Assumptions in the Human Health SQROs

Assumption	Uncertainty	Over/Under-Estimate Risk	Rationale
Exposure Assessment			
Receptor exposure durations and frequencies	Moderate	Neutral/ Overestimate	Receptor exposure durations and frequencies for the member of the public were based on site-specific assumptions. These are likely conservative in nature as there are no identified discrete receptor locations in the vicinity of Meadowbank Complex, other than grave sites and fishing locations near Whale Tail Mine. For threshold POPCs, an exposure term of 1 was assumed for the development of the SQROs as an initial assessment as per Health Canada (2021a); however, where SQROs were deemed to be unreasonably low, a more detailed assessment was considered.
Body weights, soil ingestion rates, soil loading to exposed skin	Low	Neutral	Assumptions were based on those provided by Health Canada. The use of the Health Canada (2021a) assumptions is considered to provide realistic receptor characteristics as they are based on the Canadian population.
Site-specific soil to plant bioaccumulation factors	Low	Neutral	Site-specific bioaccumulation factors for berries, lichens and sedges were calculated from pair soil and vegetation samples collected from the site. This provides a realistic estimate of the uptake of POPCs from soil into plants.
Ingestion of berries	Moderate	Overestimate	The ingestion rate, exposure duration and frequency of the member of the public consuming berries are considered to be conservative assumptions. Ingestion rate of berries was obtained from the Kuhnlein et al. (2000) study of Inuit communities and represent geomean values (Table 2.2; 0.0064 kg wet weight/day for toddler and 0.0018 kg wet weight/day for adult). It was assumed that harvested berries could be brought home and stored or frozen and were consumed 365 days per year. Information on actual rates of ingestion, exposure duration and frequency would be required to reduce uncertainty.
Ingestion of caribou	Moderate	Overestimate	The ingestion rate, exposure duration and frequency of the member of the public consuming caribou meat and organs are considered to be conservative assumptions. The moderate consumption scenario from the WLCFSLRA (Agnico Eagle 2024) was used in the derivation of the SQROs.
Ingestion of goose meat	Moderate	Overestimate	The frequency of ingestion of goose meat is likely overestimated as only 7% of the population of Baker Lake was found to consume this food, at a frequency of less than one day per month (Agnico Eagle 2024).

Table 2.19: Uncertainties and Assumptions in the Human Health SQROs

Assumption	Uncertainty	Over/Under-Estimate Risk	Rationale
Toxicity Assessment			
Toxicity Reference Values used in assessment	Low	Overestimate	TRVs used in the development of the SQROs were preferentially selected from Health Canada (2021b). TRVs are often derived from animal studies. Uncertainty factors are applied to the TRV derived from the studies to account for inter- and intraspecies variability as well as other factors.
Toxicity of mixtures	Moderate	Underestimate	There is a potential for exposure to multiple POPCs. Combined toxic effects may be produced in a receptor due to exposure to interacting POPCs. Combined effects may be additive, synergistic or antagonistic. Detailed studies of the interactions between POPCs are required, and little scientific literature is available in this regard.
Risk Characterization			
Use of an HQ of 0.2	Low	Overestimate	Application of a target HQ of 0.2 for metal POPCs is considered conservative and is protective in the event that exposure could occur from other sources.
Use of an ILCR of $1x10^{-5}$	Low	Overestimate	Application of a target ILCR of $1x10^{-5}$ as recommended by Health Canada (2021a) is conservative relative to background cancer rates.

3 ECOLOGICAL HEALTH-BASED SOIL QUALITY REMEDIATION OBJECTIVES

3.1 Receptors of Concern

As discussed in Section 1, the development of the ecological health-based SQROs considered direct contact with soil by terrestrial plants and soil invertebrates, and incidental ingestion of soil and ingestion of plants and prey that have accumulated POPCs from soil and exposure by mammals and birds.

The receptors of concern (ROCs) considered in the development of the SQROs were consistent with the WCFSLRA Plan (Agnico Eagle 2024), with the addition of terrestrial plants and soil invertebrates and the exclusion of the semi-palmated sandpiper. The WCFSLRA Plan considered five groups of ROCs and representative species from each group: ungulates (caribou), small mammals (northern red-backed vole), waterfowl (Canada goose), songbirds (Lapland longspur), and shorebirds (semi-palmated sandpiper). These choices were determined from the projects initial Final Environmental Impact Statement (FEIS; Cumberland 2005), which included discussions with stakeholders, public meetings, traditional knowledge and experience from other mines.

The development of the SQROs included the following ROCs:

- Plants and soil invertebrates;
- Northern red-backed vole;
- Caribou;
- Lapland longspur; and

- Canada goose.

The semi-palmated sandpiper was not included because it receives all its exposure through sediment pathways rather than soil, and thus exposure of this ROC is not applicable for the development of SQROs.

3.2 Protection Goals and Endpoints

Consistent with the WCFSLRA Plan (Agnico Eagle 2024), the protection goal for the development of the SQROs was to maintain populations of ROCs given that there were no rare or endangered species present at the Site (Azimuth 2006, as cited by Agnico Eagle 2024). Therefore, TRVs based on the lowest observable adverse effect levels (LOAELs) were considered as the appropriate benchmark for determining potential adverse effects to populations (Section 3.4.2).

3.3 Exposure Assessment

3.3.1 Terrestrial Plants and Soil Invertebrates

For terrestrial plants and soil invertebrates, exposure is expressed as the concentration of a POPC in soil (mg/kg dw). This permits the evaluation of exposure relative to toxicity benchmarks (e.g., TRVs) that are expressed in this way.

For the development of the SQROs, there was no adjustment for exposure to soil as terrestrial plants and immobile soil invertebrates are considered sessile receptors and could be exposed to soil in the areas with the maximum measured concentrations of POPCs.

3.3.2 Mammals and Birds

The exposure to a POPC for higher trophic level receptors is estimated as a total dose of that POPC, which represents the intake of the POPC expressed as milligram per kilogram of body weight per day. In the development of SQROs, estimated doses were calculated for mammal and bird ROCs from incidental ingestion of soil and ingestion of food items (sedges, lichens, berries, insects) that have bioaccumulated POPCs from soil.

3.3.2.1 Receptor Characteristics

To estimate the exposure dose, the concentration of the POPC in each of the relevant food items and characteristics about the ROC (e.g., dietary ingestion rates, soil ingestion rates, and proportion of the diet represented by important food items) were considered. The receptor characteristics considered are based on the same characteristics provided in the WCFSLRA Plan, unless noted in the sections below. Where necessary, conversions between wet and dry weight were completed using site-specific moisture content in plants.

As discussed in Section 2.1.7, the Canada goose was assumed to have a diet of 50% sedges and 50% berries (rather than 45% berries/ 5% insects). Insects were not included in the diet as US EPA (1993) indicates that the Canada goose diet comprises <1% insects and abundant insects are not expected in the Arctic climate.

The receptor characteristics applied in the development of the SQROs are summarized in Table 3.2.

3.3.2.2 Dietary Uptake Efficiency

The dietary uptake efficiency (biotransfer or absorption) of a chemical is the proportion of the chemical that is absorbed through the intestinal tract relative to the total amount ingested. In the absence of site-specific information, all ingested POPCs were assumed to be 100% bioavailable from the gastrointestinal tract. This is consistent with the approach in the WCFSLRA Plan (Agnico Eagle 2024).

3.3.2.3 Time in Area

Exposure estimates are typically adjusted using the time in area factor (foraging range factor), which represents the proportion of the receptor's territory or foraging range which overlaps with the area impacted by mine-related POPCs. The time in area factors used in the development of SQROs are consistent with the WCFSLRA Plan and are provided in Table 3.2.

3.3.2.4 Predictive Concentrations in Plants and Insects

The accumulation of POPCs from soil to plants was estimated using site-specific BAFs and literature-based uptake equations/BCFs following the methods described in Section 2.1.5. These BAFs and predicted concentrations in plants are presented in Table 3.3 (Berries), Table 3.4 (Lichens), Table 3.5 (Sedges).

For the accumulation of POPCs into insects, uptake models consistent with the WCFSLRA Plan were used for five metals (i.e., arsenic, cadmium, copper, lead and zinc). For other metals, rather than assume a BAF of 1, as was done in the WCFSLRA, other literature sources of bioaccumulation models were used if available. Sources of bioaccumulation models used included the following:

- US EPA. 2007. Guidance for Developing Ecological Soil Screening Levels (Eco-SSL). Soil to earthworm uptake equation (antimony, barium, beryllium, chromium, cobalt, manganese, selenium, vanadium).
- US EPA. 1999. Screening Level Ecological Risk Assessment Protocol. Appendix C - Soil to soil invertebrate bioconcentration factor (cyanide, methylmercury, nickel, thallium).
- Sample et al. 1999. Simple regression on combined model and validation data sets (inorganic mercury adopted from total mercury).
- Sample et al. 1998. Median uptake factor (molybdenum, strontium, uranium).
- Jager 1998, as cited in US EPA. 2007. BAF for trichloroethylene was estimated using guidance provided by US EPA 2007 (model taken from Jager 1998, as cited by US EPA 2007).

There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant and soil invertebrate (insect) uptake of PHCs and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

Based on its very low log K_{ow} (i.e., -0.77; US EPA 2005), methanol is not expected to accumulate into insect tissues to any significant extent. Concentrations in insects were assumed to be negligible.

For POPCs where no bioaccumulation model was available (e.g., tin), a BAF of 1 was conservatively assumed. Concentrations in insects were converted to a wet weight assuming a moisture content of 84% in insects (earthworms) based on literature percent water contents (Sample and Suter 1994). The literature uptake equations for insects used in the development of the SQROs are presented in Table 3.6.

3.3.2.5 Exposure Doses

The exposure equations used to estimate the daily dose of a POPC from soil and food ingestion are based on CCME (2020) and are presented in the sections below.

Exposure doses from incidental soil ingestion and food consumption were calculated for each terrestrial mammal and bird ROC using the following equation based on CCME (2020):

$$Dose_{soil+food} = TIA \times \left[\frac{SIR \times C_{soil}) + (FIR \times C_b \times P_b) + (FIR \times C_l \times P_l) + (FIR \times C_s \times P_s) + (FIR \times C_i \times P_i)}{BW}\right]$$

Where:

$Dose_{soil+food}$	= Estimated dose of the POPC from incidental soil ingestion and food consumption (mg/kg-d)
TIA	= Time in area factor (unitless)
SIR	= Soil ingestion rate (kilograms in dry weight per day [kg dw/d])
C_{soil}	= POPC concentration in the soil (milligrams per kilograms in dry weight [mg/kg dw])
FIR	= Food ingestion rate (kilograms in wet weight per day [kg ww/d])
C_b	= POPC concentration in berries (mg/kg ww)
P_b	= Proportion in diet – berries (unitless)
C_l	= POPC concentration in lichens (mg/kg ww)
P_l	= Proportion in diet – lichens (unitless)
C_s	= POPC concentration in sedges (mg/kg ww)
P_s	= Proportion in diet – sedges (unitless)
C_i	= POPC concentration in insects (mg/kg ww)
P_i	= Proportion in diet – insects (unitless)
BW	= Receptor's body weight (kg)

3.4 Effects Assessment

The effects assessment characterizes potential effects associated with POPCs. It provides a basis for evaluating what is an acceptable exposure and what level of exposure may adversely affect the health of ecological receptors. This involves identification of the potentially toxic effects of the POPCs and determining concentrations or doses that receptors can be exposed to without adverse effects. For terrestrial plants and soil invertebrates, this is expressed as an acceptable concentration in the media to which the ecological receptor is exposed (i.e., soil) and is referred to as the toxicity benchmark or TRV. For mammals and birds, the TRV is expressed as an acceptable dose derived from ingested exposures. These values are used as thresholds for comparison with exposure concentrations during risk characterization.

3.4.1 Terrestrial Plants and Soil Invertebrates

For terrestrial plants and soil invertebrates, the TRVs are based on effects on survival, growth, and reproduction. The CCME (1999 and updates; 2008) derived guidelines/standards for soil that are considered to be protective of direct contact by both terrestrial plants and soil invertebrates. These derivations involved the generation of extensive datasets of toxicity data and the identification of suitable toxicity data for guideline/standard development. The CCME soil quality guideline for environmental health (SQG_E) and Canada-Wide Standards (CWS) for direct soil contact for residential/parkland land use and coarse-grained soil were used as the TRVs for terrestrial plants and soil invertebrates. Where CCME SQG_E were not available, the lower of the US EPA Eco-SSLs for plants and soil invertebrates were used (US EPA 2024b).

In the absence of TRVs from CCME and US EPA, the Ontario MECP soil quality component values (Table 3 Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use, coarse soil texture (MOECC 2016) and the toxicological benchmark for plants from Efroymson et al. (1997) was used. The TRVs for terrestrial plants and soil invertebrates are presented in Table 3.7.

There are no TRVs for strontium. Strontium is a trace mineralogical constituent that is not commonly assessed in risk assessments due to low toxicity to animals and/or lack of criteria. Strontium is required for the normal development of some unicellular organisms and is readily absorbed by plants via their calcium uptake pathway (WHO 2010). Strontium is not considered to be toxic to ecological receptors (except when ingested/exposed in extreme quantities). Therefore, the ecological health-based SQRO for strontium did not consider exposure to plants and soil invertebrates and was based on wildlife receptors only.

3.4.2 Mammals and Birds

For mammals and birds, the TRVs are based on an acceptable daily dose that has been extrapolated from effects-based studies for protection of growth, reproduction, and/or survival endpoints as presented in the WCFSLRA (Agnico Eagle 2024). The TRVs are usually defined by the no observed adverse effect level (NOAEL) or LOAEL derived from oral exposures in representative species. The use of the NOAEL assumes no adverse effects will occur and the individual species will be protected. The use of the LOAEL assumes some adverse effects may occur to sensitive individuals.

Because the protection goal for the SQROs is to have no adverse effect of POPCs on populations of ROCs, LOAELs were used in the development of the SQROs. In cases where a LOAEL was not available, a NOAEL was used. The TRVs used for mammals and birds are presented in Table 3.8.

3.5 Calculation of Ecological Soil Quality Remediation Objectives

The risk estimate for ecological health is expressed as a HQ, which is calculated as the estimated exposure dose (Section 3.3) divided by the TRV (Section 3.4), as follows:

$$HQ = \frac{\text{Estimated Exposure (mg/kg or mg/kg/day)}}{\text{TRV (mg/kg or mg/kg/day)}}$$

Ecological health-based SQROs were developed based on a target HQ of 1.0, which is considered to be an acceptable level of risk for ecological health (CCME 2020). This is consistent with the WCFSLRA Plan (Agnico Eagle 2024).

For plants and soil invertebrates, the estimated exposure is equal to the soil concentration (e.g., the SQRO). Therefore, because the target HQ is 1.0, the SQROs for plants and soil invertebrates are equal to the TRVs described in Section 3.4.1 and presented in Table 3.7.

For mammals and birds, the estimated exposure is equal to the calculated dose from incidental soil ingestion and consumption of food items and adjusting for time in area (Section 3.4). This dose is compared to the TRVs (i.e., LOAELs, or NOAELs in the absence of a LOAEL). The SQROs were calculated using the “goal seek” function in Microsoft Excel which iteratively changes the input soil concentration in the equations used to calculate doses and HQs for the wildlife ROCs and exposure pathways to obtain HQs of 1.0.

The exposure doses and HQs are provided in Table 3.9 (Northern Red-Backed Vole), Table 3.10 (Caribou), Table 3.11 (Lapland Longspur) and Table 3.12 (Canada Goose).

The overall ecological health SQRO was selected as the lowest values of all receptors (Table 3.1).

3.6 Uncertainties

Numerous assumptions were made in the development of ecological health SQROs. The most significant assumptions and their implications on the SQROs are presented in Table 3.13. In general, the assumptions are conservative and overestimate risk.

Table 3.13: Uncertainties and Assumptions in the Ecological Health SQROs

Assumption	Uncertainty	Over/Under-Estimate Risk	Rationale
Exposure Assessment			
Receptor exposure durations and frequencies	Moderate	Neutral/ Overestimate	Receptor exposure durations and frequencies for the member of the public were based on site-specific assumptions. These are likely conservative in nature as there are no identified discrete receptor locations in the vicinity of Meadowbank Complex, other than grave sites and fishing locations near Whale Tail Mine. For threshold POPCs, an exposure term of 1 was assumed for the development of the SQROs as an initial assessment as per Health Canada (2021a); however, where SQROs were deemed to be unreasonably low, a more detailed assessment was considered.
Receptor characteristics	Low	Neutral	Receptor characteristics for mammals and birds were taken from various literature sources. In general, these characteristics are considered to provide reasonable estimates of exposure.
Site-specific soil to plant bioaccumulation factors	Low	Neutral	Site-specific bioaccumulation factors for berries, lichens and sedges were calculated from pair soil and vegetation samples collected from the site. This provides a realistic estimate of the uptake of POPCs from soil into plants.
Literature soil to insect bioaccumulation factors	Moderate	Neutral/ Overestimate	Bioaccumulation factors were used to estimate uptake of POPCs from soil into insects. These factors are generally conservative and overestimate concentrations in insects.
Toxicity Assessment			
Toxicity Reference Values for Plants	Low	Overestimate	The TRVs used for plants and soil invertebrates are typically based on laboratory studies using crop species which may be more or less sensitive than species found at the Site.
Toxicity Reference Values for Mammals and Birds	Low	Underestimate/ Neutral/ Overestimate	The TRVs used for mammals and birds are sometimes based on toxicity studies using laboratory/domestic species and not wildlife species. Wildlife species may be more or less sensitive than laboratory/domestic species.
Risk Characterization			
Toxicity of mixtures	Moderate	Underestimate	There is a potential for exposure to multiple POPCs. Combined toxic effects may be produced in a receptor due to exposure to interacting POPCs. Combined effects may be additive, synergistic or antagonistic. Detailed studies of the interactions between POPCs are required, and little scientific literature is available in this regard.
Risk characterization of terrestrial plants, soil invertebrates, aquatic life, and mammals and birds.	Moderate	Overestimate	Individual level endpoints of survival, growth and reproduction were used for ROCs and extrapolated to population-level effects (population level effects are considered to be ecologically relevant). However, individual-level endpoints do not necessarily translate to population-level effects which could overestimate risks to these ROCs.

4 SUMMARY AND CONCLUSIONS

Based on the results of the CRP HHERA, there were negligible risks to human, terrestrial and aquatic receptors as a result of predicted Post-Closure conditions at the Meadowbank Complex (WSP 2024c). Nevertheless, SQROs for metals and spill contaminants were developed to be used to support closure activities to identify areas of the mine and soil volumes requiring remediation. The list of POPCs for which SQROs were developed is provided in Section 1 and include the metals assessed in the WCFSLRA Plan (Agnico Eagle 2024) and the spill contaminants identified in the Phase Two Environmental Site Assessments conducted to date (WSP 2024a,b) (i.e., trichloroethylene, PHC F2, methanol, cyanide). The SQROs were developed based on the relevant receptors and exposure pathways evaluated in CRP HHERA and the WCFSLRA Plan (Agnico Eagle 2024).

As presented in Table 4.1, SQROs protective of both human health and the environment were derived for the Site as the lower of the human health-based SQROs and the ecological-based SQROs. However, the SQROs were not set below the background soil concentration (e.g., maximum background [baseline] soil concentrations described in Section 4.1 of the CRP HHERA) or more stringent than the generic soil quality guidelines (i.e., CCME SQGs for the Protection of Environmental and Human Health; CCME 2024). The SQROs for the Site represent acceptable levels of risk to human health and the environment (Table 4.1).

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Tables

Table 2.1: Soil Quality Remediation Objectives (SQROs) for Human Health
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Threshold Effects [a]				Non-Threshold Effects [b]				Human Health SQRO
	Soil Direct Contact	Consumption of Berries	Consumption of Caribou	Consumption of Goose	Soil Direct Contact	Consumption of Berries	Consumption of Caribou	Consumption of Goose	
Trichloroethylene	821	48	**48**	36758	1205001	2708	6550	15000000	48
PHC F2 (C10-C16)	**50122**	NA	NA	NA	NA	NA	NA	NA	50122
Methanol	148295	**820**	4001673	3016855361	NA	NA	NA	NA	820
Cyanide	763	**0.82**	4002	3016855	NA	NA	NA	NA	0.82
Antimony	152	**44**	452	1144642	NA	NA	NA	NA	44
Arsenic	280	3314735	446	490984	901	143717183	**199**	800000	199
Barium	76343	**19458**	4058573	3331075799	NA	NA	NA	NA	19458
Beryllium	763	**46**	6087	2832237	NA	NA	NA	NA	46
Cadmium	522	**7.1**	5135	5601	NA	NA	NA	NA	7.1
Chromium (VI)	840	214	400	998762	NA	NA	NA	NA	214[c]
Chromium (III)	572571	145932	823877	681355790	NA	NA	NA	NA	
Cobalt	652	246	**118**	145721	NA	NA	NA	NA	118
Copper	199364	**2153**	124620	19999559	NA	NA	NA	NA	2153
Lead	**2711**	17854	36694	18750736	NA	NA	NA	NA	2711
Manganese	1854	**2.0**	177451	204604466	NA	NA	NA	NA	2.0
Mercury (inorganic)	23	**0.70**	8.64E-01	7.57E+02	NA	NA	NA	NA	0.70
Methylmercury	93	**76**	459	53605	NA	NA	NA	NA	76
Molybdenum	3261	144	**114**	61267	NA	NA	NA	NA	114
Nickel	**4802**	5095821	5561	6541986	NA	NA	NA	NA	4802
Selenium	3718	**27**	933	1108	NA	NA	NA	NA	27
Strontium	**44488**	5.40E+16	6065526	6547367726	NA	NA	NA	NA	44488
Thallium	8.8	**0.39**	0.67	543	NA	NA	NA	NA	0.39
Tin	44488	68750	**13997**	11369720	NA	NA	NA	NA	13997
Uranium	**229**	516	3950	9487749	NA	NA	NA	NA	229
Vanadium	**793**	9.87E+60	1113	1923691	NA	NA	NA	NA	793
Zinc	217577	**7168**	19153915	62705145	NA	NA	NA	NA	7168

Notes:

Bold and Shaded indicates that the overall SQRO is based on this exposure pathway

All units in milligrams per kilogram dry weight (mg/kg dw).

(a) All threshold effects are based on a toddler, except for underlined POPCs that are based on a pregnant female to protect against developmental effects. Derived to be protective of unacceptable risks from exposure pathway (based on a target hazard quotient of 0.5 for PHCs, 1.0 for lead or 0.2 for all other parameters)

(b) All non-threshold effects are based on an adult. Derived to be protective of unacceptable risks from exposure pathway (based on an incremental lifetime cancer risk of 0.00001)

(c) The human health SQRO for chromium was based on the lower of the SQROs for chromium (VI) and chromium (III).

POPC = parameter of potential concern; SQRO = soil quality remediation objective; NA = not applicable

Table 2.2: Receptor Characteristics
Meadowbank Complex Soil Quality Remediation Objectives

Parameter	Member of the Public		
	Toddler [c]	Adult	Female
Age	0.5 to 4.5 yrs	≥ 20 yrs	≥ 20 yrs
Years at specific life stage	4	60	60
Body weight (kg)	16.5	70.7	70.7
Soil ingestion rate (kg/d)	NA	0.00002	0.00002
Inhalation rate (m^3/day)	NA	16.6	16.6
Ingestion rate - berries (kg ww/d)[a]	0.0064	0.0018	0.0018
Ingestion rate - caribou meat (kg ww/d)[b]	0.089	0.208	0.208
Ingestion rate - caribou organs (kg ww/d)[b]	0.00056	0.0013	0.0013
Ingestion rate - goose meat (kg ww/d)[b]	0.0056	0.013	0.013
Skin Surface Area (cm^2)			
Hands	NA	890	890
Arms (upper and lower)	NA	2500	2500
Legs (upper and lower)	NA	5720	5720
Soil loading to exposed skin (kg/cm^2/event)			
Hands	NA	1.00E-07	1.00E-07
Surfaces other than hands	NA	1.00E-08	1.00E-08

Notes:

Based on Health Canada (2021) unless otherwise indicated.

(a) Average ingestion rates based on Inuit communities (Kuhnlein et al. 2000).

(b) Agnico Eagle (2024) Meadowbank Complex Wildlife and $HHRA_{country\ foods}$ Screening Level Risk Assessment Plan. Represents moderate consumption rates.

(c) Toddler food consumption values are 43% of adult values per Richardson (1997).

yrs = years; kg = kilogram; kg/d = kilogram per day; NA = not applicable; m^3/day = cubic metre per day; kg ww/d = kilogram wet weight per day; cm^2 = square centimetre; kg/cm^2/event = kilogram per square centimetre per event.

References:

Health Canada. 2021. Federal Contaminated Site Risk Assessment in Canada, Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0. 2021.

Agnico Eagle. 2024. Meadowbank Complex Wildlife and HHRAcountry foods Screening Level Risk Assessment Plan

Kuhnlein HV, Receveur O, Chan HM, Loring E. 2000. Assessment of Dietary Benefit/Risk in Inuit Communities. Centre for Indigenous Peoples Nutrition and Environment. August, 2000.

Richardson GM. 1997. Compendium of Canadian Human Exposure Factors for Risk Assessment. Ottawa: O'Connor Associates Environmental Inc.

Table 2.3: Exposure Durations and Frequencies
Meadowbank Complex Soil Quality Remediation Objectives

Parameter	Member of the Public		
	Toddler	Adult	Female[e]
Hours per day on Site[a]	NA	24	NA
Days per week on Site[a]	NA	7	NA
Weeks per year on Site[a]	NA	2 [f]	NA
Weeks per year consuming country foods [d]	52	52	NA
Dermal exposure events (per day) [a]	NA	1	1
Years exposed [b]	NA	60	NA
Life expectancy [b]	NA	80	NA
Days per week ingesting plants [c]	7	7	NA
Days per week ingesting wild game [d]	3 [f]	3 [f]	NA
Days per week ingesting wild game organs [d]	1 [f]	1 [f]	NA
Days per week ingesting waterfowl [d]	1 [f]	1 [f]	NA

Notes:

NA – not applicable; parameter considered in evaluation of non-threshold effects only, therefore is not applicable to the toddler, or is not applicable to the female because dose averaging can not be applied to developmental toxicants.

(a) It was assumed that members of the public may visit the area seasonally in the summer months (e.g., when exposure to Site media would be expected to be the highest) for up to 14 days per year during extended hunting trips in the area.

(b) Health Canada (2021).

(c) Assumption.

(d) Agnico Eagle (2024) Meadowbank Complex Wildlife and $HHRA_{country\ foods}$ Screening Level Risk Assessment Plan. Represents moderate consumption rates. Consumption of wild game organs for 1 day per week was conservatively considered.

(e) Trichloroethylene, lead, methylmercury, and vanadium are considered developmental toxicants and as such, a female was considered for the evaluation of threshold risks.

(f) Per Health Canada (2021) dose averaging was not applied for threshold parameters of potential concern as an initial assessment (assumed 52 weeks per year), otherwise detailed chemical-specific rationale is required to determine if dose-averaging is applicable based on the toxicokinetics of the chemical.

References:

Health Canada. 2021. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 3.0. 2021.

Agnico Eagle. 2024. Meadowbank Complex Wildlife and HHRAcountry foods Screening Level Risk Assessment Plan

Table 2.4: Relative Absorption Factors (RAFs)
Meadowbank Complex Soil Quality Remediation Objectives

POPC	RAF_{Oral}		RAF_{Derm}		RAF_{Inh}	
Trichloroethylene	1	(a)	0.03	(a)	1	(a)
PHC F2 (C10-C16)	1	(a)	0.2	(b)	1	(a)
Aliphatic C10-C12	1	(a)	0.2	(b)	1	(a)
Aliphatic C12-C16	1	(a)	0.2	(b)	1	(a)
Aromatic C10-C12	1	(a)	0.2	(b)	1	(a)
Aromatic C12-C16	1	(a)	0.2	(b)	1	(a)
Methanol	1	(a)	1	(c)	1	(a)
Cyanide	1	(a)	0.1	(b)	1	(a)
Antimony	1	(a)	0.1	(b)	1	(a)
Arsenic	0.5	(b)/(e)	0.03	(a)	1	(a)
Barium	1	(a)	0.1	(a)	1	(a)
Beryllium	1	(a)	0.1	(a)	1	(a)
Cadmium	1	(a)	0.01	(a)	1	(a)
Chromium (VI)	1	(a)	0.1	(a)	1	(a)
Chromium (III)	1	(a)	0.1	(a)(f)	1	(a)
Cobalt	1	(a)	0.01	(b)	1	(a)
Copper	1	(a)	0.06	(a)	1	(a)
Lead	0.6	(e)/(g)	0.006	(a)	1	(a)
Manganese	1	(a)	1	(c)	1	(a)
Mercury (inorganic)	0.5	(b)/(e)	1	(a)	1	(a)
Methylmercury	1	(a)	0.06	(a)	1	(a)
Molybdenum	1	(a)	0.01	(b)	1	(a)
Nickel	1	(a)	0.09	(a)	1	(a)
Selenium	1	(a)	0.01	(a)	1	(a)
Strontium	1	(a)	1	(c)	1	(a)
Thallium	1	(a)	0.01	(b)	1	(a)
Tin	1	(a)	1	(c)	1	(a)
Uranium	1	(a)	0.1	(a)	1	(a)
Vanadium	1	(a)	0.1	(b)	1	(a)
Zinc	1	(a)	0.1	(a)	1	(a)

Notes:

(a) Health Canada (2021).

(b) Ontario MOECC (2016).

(c) Value was conservatively assumed to be 1 in absence of guidance from Health Canada and the Ontario MOECC.

(e) RAF_{oral} is only applicable to soil exposures, therefore a RAF of 1 was used for the consumption of plants and wild game pathways.

(f) Value for total chromium used as surrogate.

(g) MECP (2024). RAF = 1 for pregnant female and 0.6 for adult.

POPC = parameter of potential concern; RAF = relative absorption factor; RAFOral = relative absorption factor from the gastrointestinal tract; RAFDerm = relative dermal absorption factor; RAFInh = relative absorption factor for inhalation; PHC = petroleum hydrocarbon.

References:

Health Canada. 2021. Federal Contaminated Site Risk Assessment In Canada: Toxicological Reference Values (TRVs).

MECP (Ontario Ministry of the Environment Conservation and Parks). 2024. Lead in Soil Part II: Relative Absorption Factors and Source Allocation Factors for Use with Selected Toxicity Reference Values.

MOECC (Ontario Ministry of the Environment and Climate Change). 2016. Modified Generic Risk Assessment "Approved Model". November 2016.

Table 2.5: Petroleum Hydrocarbon (PHC) Fraction Composition
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Proportion in Soil
Petroleum Hydrocarbons - F2 (C10-C16)	1
Aliphatic C10-C12	0.36
Aliphatic C12-C16	0.44
Aromatic C10-C12	0.09
Aromatic C12-C16	0.11

Notes:

All values based on CCME (2008) unless otherwise indicated

POPC = Parameter of potential concern

(a) Values provided for soil were adopted for sediment.

(b) Adopted proportions from petroleum hydrocarbons F4.

References:

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

Table 2.6: Exposure Point Concentrations for POPCs in Plants - Berries
Meadowbank Complex Soil Quality Remediation Objectives

POPC	SQRO for Consumption of Berries [a] (mg/kg)	SQRO for Consumption of Caribou Meat [a] (mg/kg)	SQRO for Consumption of Goose Meat [a] (mg/kg)	Site-Specific BAF or Literature Uptake Factor		Calculated EPC in Berries for Plant Consumption (mg/kg-ww)	Calculated EPC in Berries for Caribou Consumption (mg/kg-ww)	Calculated EPC in Berries for Goose Consumption (mg/kg-ww)
Threshold POPC								
Trichloroethylene	48	48	36758	Cp = 1.59 × Cs	(d,e)	11	11	8767
PHC F2 (C10-C16)	NA	NA	NA	NA	(f)	NA	NA	NA
Aliphatic C10-C12	NA	NA	NA	NA	(f)	NA	NA	NA
Aliphatic C12-C16	NA	NA	NA	NA	(f)	NA	NA	NA
Aromatic C10-C12	NA	NA	NA	NA	(f)	NA	NA	NA
Aromatic C12-C16	NA	NA	NA	NA	(f)	NA	NA	NA
Methanol	820	4001673	3016855361	Cp = 8.38 × Cs	(d,e)	1031	5030103	3792187189
Cyanide	0.82	4002	3016855	Cp = 8.38 × Cs	(d,e)	1.0	5030	3792187
Antimony	44	452	1144642	$\ln(C_p) = 0.938 \times \ln(C_s) - 3.233$	(g,e)	0.21	1.8	2851
Arsenic	3314735	446	490984	LogBAF = -0.8334xLogSoil -1.8954	(b)	0.16	0.04	0.11
Barium	19458	4058573	3331075799	Cp = 0.0053 x Cs	(b)	103	21510	17654702
Beryllium	46	6087	2832237	Cp = 0.0224 x Cs	(b)	1.0	136	63442
Cadmium	7.1	5135	5601	Cp = 0.058 x Cs	(b)	0.41	298	325
Chromium (VI)	214	400	998762	Cp = 0.0053 x Cs	(b,c)	1.1	2.1	5293
Chromium (III)	145932	823877	681355790	Cp = 0.0053 x Cs	(b,c)	773	4367	3611186
Cobalt	246	118	145721	Cp = 0.0021 x Cs	(b)	0.52	0.25	306
Copper	2153	124620	19999559	Cp = 0.102 x Cs	(b)	220	12711	2039955
Lead	17854	36694	18750736	Cp = 0.0011 x Cs	(b)	20	40	20626
Manganese	2.0	177451	204604466	LogBAF = -1.0813xLogSoil + 1.1339	(b)	13	5.1	2.9
Mercury (inorganic)	0.70	0.86	756.775173117	Cp = 0.2222 × Cs	(i)	0.15	0.2	1.7E+02
Methylmercury	76	459	53605	Cp = 0.137 × Cs	(j,e)	1.6	9.4	1102
Molybdenum	144	114	61267	Cp = 0.0179 x Cs	(b)	2.6	2.0	1097
Nickel	5095821	5561	6541986	LogBAF = -0.7535xLogSoil - 0.863	(b)	6.2	1.1	6.6
Selenium	27	933	1108	ln(Cp) = 1.104 × ln(Cs) - 0.677	(g,e)	3.0	145	175
Strontium	5.4E+16	6065526	6547367726	LogBAF = -0.8123xLogSoil - 0.6504	(b)	309	4.2	16
Thallium	0.39	0.67	543	Cp = 0.0177 x Cs	(b)	0.0070	0.012	9.6
Tin	68750	13997	11369720	Cp = 0.03 x Cs	(h,e)	309	63	51164
Uranium	516	3950	9487749	Cp = 0.0006 x Cs	(b)	0.31	2.4	5693
Vanadium	9.9E+60	1113	1923691	LogBAF = -0.9559xLogSoil -1.4733	(b)	16	0.046	0.064
Zinc	7168	19153915	62705145	Cp = 0.041 x Cs	(b)	294	785310	2570911
Non-Threshold POPC								
Trichloroethylene	2708	6550	15000000	Cp = 1.59 × Cs	(d,e)	646	1562	3577500
Arsenic	143717182.5	198.918602	800000	LogBAF = -0.8334xLogSoil -1.8954	(b)	0.29	0.031	0.12

Notes:

(a) SQRO represents the soil concentration that results in negligible risk. Presented in dry weight.

(b) Site-specific BAF presented in wet weight.

(c) Total chromium applied as a surrogate.

(d) US EPA (2005). Uptake factors for above ground produce applied.

(e) Converted to wet weight assuming a moisture content of 85% in berries based on site-specific average tissue moisture content.

(f) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(g) US EPA (2007). Soil to Plants Uptake Equation.

(h) Baes et al. (1984). Soil to plant concentration factor.

(i) Adopted site-specific BAF for total mercury.

(j) US EPA 1999. Soil to plant bioconcentration factor.

POPC = parameter of potential concern; SQRO = soil quality remediation objective; mg/kg ww = milligrams per kilogram wet weight; BAF = bioaccumulation factor; EPC = exposure point concentration; Cp = concentration in berries; Cs = concentration in soil; PHC = petroleum hydrocarbon; NA = not applicable.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

US EPA 1999. Screening Level Ecological Risk Assessment Protocol. Appendix C – Media-to-Receptor Bioconcentration Factors (BCFs).

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

US EPA. 2007. Guidance for Developing Ecological Soil Screening Levels (Eco-SSL). Attachment 4-1. OSWER Directive 9285.7-55. Table 4a. Uptake Equations for Inorganics. Revised April 2007.

Table 2.7: Exposure Point Concentrations for POPCs in Plants - Lichens
Meadowbank Complex Soil Quality Remediation Objectives

POPC	SQRO for Consumption of Caribou Meat [(a)] (mg/kg)	Site-Specific BAF or Literature Uptake Factor		Calculated EPC in Lichen for Caribou Consumption (mg/kg-ww)
Threshold POPC				
Trichloroethylene	48	Cp = 1.59 × Cs	(d,e)	58
PHC F2 (C10-C16)	NA	NA	(f)	NA
Aliphatic C10-C12	NA	NA	(f)	NA
Aliphatic C12-C16	NA	NA	(f)	NA
Aromatic C10-C12	NA	NA	(f)	NA
Aromatic C12-C16	NA	NA	(f)	NA
Methanol	4001673	Cp = 8.38 × Cs	(d,e)	25485854
Cyanide	4002	Cp = 8.38 × Cs	(d,e)	25486
Antimony	452	Cp = 0.0846*Cs	(b)	38
Arsenic	446	LogBAF = -0.9725xLogSoil + 0.2228	(b)	0.035
Barium	4058573	LogBAF = -1.0445xLogSoil + 1.2703	(b)	9.5
Beryllium	6087	LogBAF = -1.3035xLogSoil -1.5339	(b)	0.0021
Cadmium	5135	LogBAF = -0.8643xLogSoil -0.93	(b)	0.37
Chromium (VI)	400	LogBAF = -0.7526xLogSoil + 0.9415	(b,c)	38
Chromium (III)	823877	LogBAF = -0.7526xLogSoil + 0.9415	(b,c)	254
Cobalt	118	LogBAF = -0.9834xLogSoil -0.0094	(b)	1.1
Copper	124620	LogBAF = -0.8585xLogSoil + 0.2635	(b)	9.6
Lead	36694	LogBAF = -0.8385xLogSoil + 0.0921	(b)	6.7
Manganese	177451	LogBAF = -1.2203xLogSoil + 2.5976	(b)	28
Mercury (inorganic)	1	Cp = 6.6 × Cs	(h)	6
Methylmercury	459	Cp = 0.137 × Cs	(i,e)	33
Molybdenum	114	Cp = 0.3792*Cs	(b)	43
Nickel	5561	LogBAF = -0.8168xLogSoil + 0.6597	(b)	22
Selenium	933	Cp = 0.3097*Cs	(b)	289
Strontium	6065526	LogBAF = -0.6418xLogSoil + 0.5956	(b)	1060
Thallium	0.67	LogBAF = -1.0062xLogSoil -1.7902	(b)	0.016
Tin	13997	Cp = 0.03 x Cs	(g,e)	319
Uranium	3950	Cp = 0.0656*Cs	(b)	259
Vanadium	1113	Cp = 0.1487*Cs	(b)	166
Zinc	19153915	LogBAF = -1.1591xLogSoil + 1.4446	(b)	1.9
Non-Threshold POPC				
Trichloroethylene	6550	Cp = 1.59 × Cs	(d,e)	7915
Arsenic	198.918602	LogBAF = -0.9725xLogSoil + 0.2228	(b)	1.9

Notes:

(a) SQRO represents the soil concentration that results in negligible risk. Presented in dry weight.

(b) Site-specific BAF in wet weight.

(c) Total chromium applied as a surrogate.

(d) US EPA (2005). Uptake factors for above ground produce applied.

(e) Converted to wet weight assuming a moisture content of 24% in lichens based on site-specific average tissue moisture content.

(f) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(g) Baes et al. (1984). Soil to plant concentration factor.

(h) Adopted site-specific BAF for total mercury.

(i) US EPA 1999. Soil to plant bioconcentration factor.

POPC = parameter of potential concern; SQRO = soil quality remediation objective; EPC = exposure point concentration; mg/kg ww = milligrams per kilogram wet weight; Cp = concentration in berries; Cs = concentration in soil; PHC = petroleum hydrocarbon; NA = not applicable.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

US EPA (United States Environmental Protection Agency). 1993. Wildlife Exposure Factor Handbook.

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

Table 2.8: Exposure Point Concentrations for POPCs in Plants - Sedges
Meadowbank Complex Soil Quality Remediation Objectives

POPC	SQRO for Consumption of Caribou Meat [(a)] (mg/kg)	SQRO for Consumption of Goose Meat [(a)] (mg/kg)	Site-Specific BAF or Literature Uptake Factor		Calculated EPC in Sedges for Caribou Consumption (mg/kg-ww)	Calculated EPC in Sedges for Goose Consumption (mg/kg-ww)
Threshold POPC						
Trichloroethylene	48	36758	Cp = 1.59 × Cs	(d,e)	39	29807
PHC F2 (C10-C16)	NA	NA	NA	(f)	NA	NA
Aliphatic C10-C12	NA	NA	NA	(f)	NA	NA
Aliphatic C12-C16	NA	NA	NA	(f)	NA	NA
Aromatic C10-C12	NA	NA	NA	(f)	NA	NA
Aromatic C12-C16	NA	NA	NA	(f)	NA	NA
Methanol	4001673	3016855361	Cp = 8.38 × Cs	(d,e)	17102349	12893436441
Cyanide	4002	3016855	Cp = 8.38 × Cs	(d,e)	17102	12893436
Antimony	452	1144642	LogBAF = -1.5097xLogSoil - 2.7317	(b)	8.2E-05	1.5E-06
Arsenic	446	490984	LogBAF = -0.9197xLogSoil -0.5449	(b)	0.47	0.82
Barium	4058573	3331075799	LogBAF = -0.9354xLogSoil + 1.0621	(b)	31	48
Beryllium	6087	2832237	LogBAF = -1.0447xLogSoil - 2.0231	(b)	0.0064	0.0049
Cadmium	5135	5600.96	LogBAF = -0.7288xLogSoil -1.4038	(b)	0.40	0.41
Chromium (VI)	400	998762	LogBAF = -0.9028xLogSoil + 0.4676	(b,c)	5.3	11
Chromium (III)	823877	681355790	LogBAF = -0.9028xLogSoil + 0.4676	(b,c)	11	21
Cobalt	118	145721	LogBAF = -0.9153xLogSoil - 0.6554	(b)	0.33	0.61
Copper	124620	19999559	LogBAF = -0.8988xLogSoil + 0.1111	(b)	4.2	7.1
Lead	36694	18750736	Cp = 0.0276 x Cs	(b)	1013	517520
Manganese	177451	204604466	LogBAF = -1.1129xLogSoil + 2.4588	(b)	73	33
Mercury (inorganic)	1	756.775173117	Cp = 0.687 x Cs	(h)	1	519.904543931
Methylmercury	459	53605	Cp = 0.137 × Cs	(i,e)	32	3745
Molybdenum	114	61267	Cp = 0.7254 x Cs	(b)	83	44443
Nickel	5561	6541986	LogBAF = -0.8261xLogSoil + 0.2413	(b)	7.8	27
Selenium	933	1108	Cp = 0.0806 x Cs	(b)	75	89
Strontium	6065526	6547367726	LogBAF = -0.7679xLogSoil + 0.527	(b)	126	639
Thallium	0.67	543	LogBAF = -1.0826xLogSoil -2.6017	(b)	0.0026	0.0015
Tin	13997	11369720	Cp = 0.03 x Cs	(g,e)	214	173957
Uranium	3950	9487749	LogBAF = -1.1471xLogSoil -1.5002	(b)	0.0093	0.0030
Vanadium	1113	1923691	Cp = 0.0279 x Cs	(b)	31	53671
Zinc	19153915	62705145	LogBAF = -1.0115xLogSoil + 1.163	(b)	12	12
Non-Threshold POPC						
Trichloroethylene	6550	15000000	Cp = 1.59 × Cs	(d,e)	5311	12163500
Arsenic	198.918602	800000	LogBAF = -0.9197xLogSoil -0.5449	(b)	0.44	0.85

Notes:

(a) SQRO represents the soil concentration that results in negligible risk. Presented in dry weight.

(b) Site-specific BAF based on wet weight.

(c) Total chromium applied as a surrogate.

(d) US EPA (2005). Uptake factors for above ground produce applied.

(e) Converted to wet weight assuming a moisture content of 49% in sedges based on site-specific average tissue moisture content.

(f) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(g) Baes et al. (1984). Soil to plant concentration factor.

(h) Adopted site-specific BAF for total mercury.

(i) US EPA 1999. Soil to plant bioconcentration factor.

POPC = parameter of potential concern; SQRO = soil quality remediation objective; mg/kg dw = milligrams per kilogram dry weight; BAF = bioaccumulation factor; EPC = exposure point concentration; Cp = concentration in sedges; Cs = concentration in soil; PHC = petroleum hydrocarbon; NA = not applicable.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

US EPA 1999. Screening Level Ecological Risk Assessment Protocol. Appendix C – Media-to-Receptor Bioconcentration Factors (BCFs).

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

Table 2.9: Exposure Point Concentrations for POPCs in Wild Game - Caribou
Meadowbank Complex Soil Quality Remediation Objectives

POPC	SQRO in Soil (mg/kg dw) [a]	Proportion in Berries (0.05)	Proportion in Lichens (0.65)	Proportion in Sedges (0.3)	Concentration in Berries (mg/kg ww)	Concentration in Lichens (mg/kg ww)	Concentration in Sedges (mg/kg ww)	Concentration in Diet (5% berries, 65% lichens, 30% sedges) (mg/kg ww) [b]	Soil Ingestion Rate (kg dw/d) [c]	Food Ingestion Rate (kg ww/d) [d]	Beef Transfer Factor (day/kg ww)		Concentration in Caribou Muscle (mg/kg ww) [h]	Muscle to Kidney Transfer Factor [i]	Concentration in Caribou Kidney (mg/kg ww)	Muscle to Liver Transfer Factor [j]	Concentration in Caribou Liver (mg/kg ww)
Threshold POPC																	
Trichloroethylene	48	0.05	0.65	0.30	11	58	39	50	0.101	3.11	0.0052	(e)	0.099	NV	NC	NV	NC
PHC F2 (C10-C16)	N/A	0.05	0.65	0.30	NA	NA	NA	NA	0.101	3.11	NA	(g)	NA	NA	NA	NA	NA
Aliphatic C10-C12	NA	0.05	0.65	0.30	NA	NA	NA	NA	0.101	3.11	NA	(g)	NA	NA	NA	NA	NA
Aliphatic C12-C16	NA	0.05	0.65	0.30	NA	NA	NA	NA	0.101	3.11	NA	(g)	NA	NA	NA	NA	NA
Aromatic C10-C12	NA	0.05	0.65	0.30	NA	NA	NA	NA	0.101	3.11	NA	(g)	NA	NA	NA	NA	NA
Aromatic C12-C16	NA	0.05	0.65	0.30	NA	NA	NA	NA	0.101	3.11	NA	(g)	NA	NA	NA	NA	NA
Methanol	4001673	0.05	0.65	0.30	1031	25485854	17102349	21696561	0.101	3.11	9.1E-06	(e)	74	NV	NC	NV	NC
Cyanide	4002	0.05	0.65	0.30	1.0	25486	17102	21697	0.101	3.11	9.1E-06	(e)	0.074	NA	NA	NA	NA
Antimony	452	0.05	0.65	0.30	0.21	38	0.000082	25	0.101	3.11	0.001	(e)	0.015	NA	NA	NA	NA
Arsenic	446	0.05	0.65	0.30	0.16	0.035	0.47	0.17	0.101	3.11	0.002	(e)	0.011	0.50	0.0055	1	0.011
Barium	4058573	0.05	0.65	0.30	103	9.5	31	21	0.101	3.11	0.00015	(e)	7.4	NA	NC	NA	NC
Beryllium	6087	0.05	0.65	0.30	1.0	0.0021	0.0064	0.055	0.101	3.11	0.001	(e)	0.074	NA	NC	NA	NC
Cadmium	5135	0.05	0.65	0.30	0.41	0.37	0.40	0.38	0.101	3.11	0.00012	(e)	0.0075	389	2.9	82	0.61
Chromium (VI)	400	0.05	0.65	0.30	1.1	38	5.3	27	0.101	3.11	0.0055	(e)	0.081	NA	NC	NA	NC
Chromium (III)	823877	0.05	0.65	0.30	773	254	11	207	0.101	3.11	0.0055	(e)	55	0.17	9.2	0.13	6.9
Cobalt	118	0.05	0.65	0.30	0.52	1.1	0.33	0.81	0.101	3.11	0.02	(f)	0.035	3.0	0.10	7.0	0.24
Copper	124620	0.05	0.65	0.30	220	10	4.2	19	0.101	3.11	0.01	(f)	15	0.86	13	5.3	81
Lead	36694	0.05	0.65	0.30	20	6.7	1013	309	0.101	3.11	0.0003	(e)	0.17	0.92	0.16	0.92	0.16
Manganese	177451	0.05	0.65	0.30	13	28	73	41	0.101	3.11	0.0004	(f)	0.87	2.8	2.5	7.5	6.5
Mercury (inorganic)	0.86	0.05	0.65	0.30	0.15	5.7	0.6	3.9	0.101	3.11	0.00522	(e)	0.008	59	0.5	13	0.10
Methylmercury	459	0.05	0.65	0.30	1.6	33	32	31	0.101	3.11	0.00078	(e)	0.013	2.0	0.027	1	0.013
Molybdenum	114	0.05	0.65	0.30	2.6	43	83	53	0.101	3.11	0.006	(f)	0.13	11	1.4	62	7.9
Nickel	5561	0.05	0.65	0.30	6.2	22	7.8	17	0.101	3.11	0.006	(e)	0.44	0.020	0.0089	0.04	0.018
Selenium	933	0.05	0.65	0.30	3.0	289	75	210	0.101	3.11	0.0023	(e)	0.20	3.6	0.73	1.894736842	0.39
Strontium	6065526	0.05	0.65	0.30	309	1060	126	742	0.101	3.11	0.0003	(f)	22	NA	NC	NA	NC
Thallium	0.67	0.05	0.65	0.30	0.0070	0.016	0.0026	0.012	0.101	3.11	0.04	(e)	0.00050	NA	NC	NA	NC
Tin	13997	0.05	0.65	0.30	309	319	214	287	0.101	3.11	0.08	(f)	22	NA	NC	NA	NC
Uranium	3950	0.05	0.65	0.30	0.31	259	0.0093	168	0.101	3.11	0.0002	(f)	0.022	NA	NC	NA	NC
Vanadium	1113	0.05	0.65	0.30	16	166	31	118	0.101	3.11	0.0025	(f)	0.14	NA	NC	NA	NC
Zinc	19153915	0.05	0.65	0.30	294	1.9	12	20	0.101	3.11	0.00009	(e)	21	0.53	11	0.53	11
Non-Threshold POPC																	
Trichloroethylene	6550	0.05	0.65	0.30	646	7915	5311	6770	0.101	3.11	0.0052	(e)	13	NV	NC	NV	NC
Arsenic	199	0.05	0.65	0.30	0.29	1.9	0.44	1.40	0.101	3.11	0.002	(e)	0.006	0.50	0.0029	1.0	0.0059

Notes:

(a) SQRO represents the soil concentration that results in negligible risk from the consumption of plants. Presented in dry weight.

(b) Concentration in plants estimated based on site-specific BAF for berries, lichens and sedges. Refer to Tables 2.6 to 2.8.

(c) Assumed 5% of dry food ingestion rate (general rate for mammals) (Beyer et al. 1994).

(d) Based on total dry food intake for herbivorous mammals from US EPA (1993) (g/day) $(0.577*(BW)^{0.727})$. Assuming a body weight of 75 kg as reported in Dauphine (1976), smallest body weight used. Converted to wet food intake assuming site specific moisture content of 35% for caribou diet (calculated from 30% sedges at 49% moisture, 65% lichens at 24% moisture, and 5% berries at 85% moisture).

(e) US EPA (2005).

(f) Baes et al. (1984).

(g) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(h) Concentration in caribou is equal to time in area x (concentration in plants x beef transfer factor x food ingestion rate) + (concentration in soil x beef transfer factor x soil ingestion rate).

(i) Time in area obtained from Agnico Eagle (2024) Meadowbank Complex Wildlife and $HHRA_{country\ foods}$ Screening Level Risk Assessment Plan.

POPC = parameter of potential concern; SQRO = soil quality remediation objective; mg/kg ww = milligram per kilogram wet weight; kg dw/d = kilogram dry weight per day; kg ww/d = kilogram wet weight per day; day/kg ww = day per kilogram wet weight; NV = no value; NC = not calculated; PHC = petroleum hydrocarbon; NA = not applicable.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

Beyer WN, Connor EE, Gerould S. 1994. Estimates of soil ingestion by wildlife. The Journal of Wildlife Management. 58(2):375-382.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

Dauphine TC Jr. 1976. Biology of the Kaminuriak population of barren-ground caribou: Part 4. Report Series No. 38, Canadian Wildlife Service.

US EPA (United States Environmental Protection Agency). 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

Table 2.10: Caribou Muscle to Kidney and Muscle to Liver Transfer Factors
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Concentration in Muscle (mg/kg ww)	Concentration in Kidney (mg/kg ww)	Concentration in Liver (mg/kg ww)	Muscle to Kidney Transfer Factor	Muscle to Liver Transfer Factor
Cyanide	NV	NV	NV	NA	NA
Antimony	NV	NV	NV	NA	NA
Arsenic	0.02	0.01	0.02	0.5	1.0
Barium	NV	NV	NV	NA	NA
Beryllium	NV	NV	NV	NA	NA
Cadmium	0.01	3.89	0.82	389.0	82.0
Chromium (VI)	NV	NV	NV	NA	NA
Chromium (III)	0.24	0.04	0.03	0.2	0.1
Cobalt	0.01	0.03	0.07	3.0	7.0
Copper	4.16	3.57	22.2	0.9	5.3
Lead	0.13	0.12	0.12	0.9	0.9
Manganese	0.39	1.11	2.93	2.8	7.5
Mercury (inorganic) [(a)]	0.01	0.59	0.13	59.0	13.0
Methylmercury	0.01	0.002	0.01	2	1
Molybdenum	0.01	0.11	0.62	11	62
Nickel	0.5	0.01	0.02	0.02	0.04
Selenium	0.19	0.68	0.36	3.58	1.89
Strontium	NV	NV	NV	NA	NA
Thallium	NV	NV	NV	NA	NA
Tin	NV	NV	NV	NA	NA
Uranium	NV	NV	NV	NA	NA
Vanadium	NV	NV	NV	NA	NA
Zinc	50	26.3	26.5	0.53	0.53

Notes:

Concentrations are based on data from all regions.

(a) Values for mercury total applied to mercury inorganic

POPC = parameter of potential concern; NV = no value; NA = not applicable because there are no values for that parameter; mg/kg ww = milligram per kilogram wet weight.

References:

University of Ottawa. 2021. First Nations Food, Nutrition and Environment Study (FNFNES) Final Report for Eight Assembly of First Nations Regions: Comprehensive Technical Report-Supplemental Data. Concentrations of essential elements in traditional food in all regions and concentrations of toxic elements in traditional food in all regions.

Table 2.11: Exposure Point Concentrations for POPCs in Wild Game - Goose
Meadowbank Complex Soil Quality Remediation Objectives

POPC	SQRO in soil (mg/kg dw)	Proportion of Berries in Diet (mg/kg ww)	Proportion of Sedges in Diet (mg/kg ww)	Concentration of berries in diet (mg/kg ww) [(a)]	Concentration of sedges in diet (mg/kg ww) [(a)]	Concentration in diet (50% berries, 50% sedges) (mg/kg ww)	Poultry Transfer Factor (day/kg ww)		Food Ingestion Rate (kg ww/d) [(d)]	Soil Ingestion Rate (kg dw/d) [(e)]	Concentration in Poultry Muscle (mg/kg ww) [(f)]
Threshold POPC											
Trichloroethylene	36758	0.5	0.5	8767	29807	19287	0.0038	(b)	0.064	0.0005	1.6
PHC F2 (C10-C16)	NA	0.5	0.5	NA	NA	NA	NA	(c)	0.064	0.0005	NA
Aliphatic C10-C12	NA	0.5	0.5	NA	NA	NA	NA	(c)	0.064	0.0005	NA
Aliphatic C12-C16	NA	0.5	0.5	NA	NA	NA	NA	(c)	0.064	0.0005	NA
Aromatic C10-C12	NA	0.5	0.5	NA	NA	NA	NA	(c)	0.064	0.0005	NA
Aromatic C12-C16	NA	0.5	0.5	NA	NA	NA	NA	(c)	0.064	0.0005	NA
Methanol	3016855361	0.5	0.5	3792187189	12893436441	8342811815	0.0000067	(b)	0.064	0.0005	1181
Cyanide	3016855	0.5	0.5	3792187	12893436	8342812	0.0000067	(b)	0.064	0.0005	1.2
Antimony	1144642	0.5	0.5	2851	0.0000015	1426	0.0010	(g)	0.064	0.0005	0.24
Arsenic	490984	0.5	0.5	0.11	0.82	0.46	0.0020	(g)	0.064	0.0005	0.18
Barium	3331075799	0.5	0.5	17654702	48	8827375	0.00015	(g)	0.064	0.0005	118
Beryllium	2832237	0.5	0.5	63442	0.0049	31721	0.0010	(g)	0.064	0.0005	1.2
Cadmium	5601	0.5	0.5	325	0.41	163	0.11	(b)	0.064	0.0005	0.47
Chromium (VI)	998762	0.5	0.5	5293	11	2652	0.0055	(g)	0.064	0.0005	1.3
Chromium (III)	681355790	0.5	0.5	3611186	21	1805603	0.0055	(g)	0.064	0.0005	886
Cobalt	145721	0.5	0.5	306	0.61	153	0.020	(g)	0.064	0.0005	0.59
Copper	19999559	0.5	0.5	2039955	7.1	1019981	0.010	(g)	0.064	0.0005	251
Lead	18750736	0.5	0.5	20626	517520	269073	0.00030	(g)	0.064	0.0005	2.7
Manganese	204604466	0.5	0.5	2.9	33	18	0.00040	(g)	0.064	0.0005	15
Mercury (inorganic)	757	0.5	0.5	168	520	344	0.024	(b)	0.064	0.0005	0.18
Methylmercury	53605	0.5	0.5	1102	3745	2423	0.0036	(b)	0.064	0.0005	0.22
Molybdenum	61267	0.5	0.5	1097	44443	22770	0.0060	(g)	0.064	0.0005	3.0
Nickel	6541986	0.5	0.5	6.6	27	17	0.0060	(g)	0.064	0.0005	7.1
Selenium	1108	0.5	0.5	175	89	132	1.13	(b)	0.064	0.0005	3.4
Strontium	6547367726	0.5	0.5	16	639	327	0.00030	(g)	0.064	0.0005	354
Thallium	543	0.5	0.5	10	0.0015	4.8	0.040	(g)	0.064	0.0005	0.0080
Tin	11369720	0.5	0.5	51164	173957	112560	0.080	(g)	0.064	0.0005	354
Uranium	9487749	0.5	0.5	5693	0.0030	2846	0.00020	(g)	0.064	0.0005	0.35
Vanadium	1923691	0.5	0.5	0.064	53671	26836	0.0025	(g)	0.064	0.0005	2.3
Zinc	62705145	0.5	0.5	2570911	12	1285461	0.0088	(b)	0.064	0.0005	336
Non-Threshold POPC											
Trichloroethylene	15000000	0.5	0.5	3577500	12163500	7870500	0.0038	(b)	0.064	0.0005	648
Arsenic	800000	0.5	0.5	0.12	0.85	0.49	0.0020	(g)	0.064	0.0005	0.29

Notes:

(a) Concentration in plants estimated based on soil concentrations. Refer to Tables 2.6 to 2.8.

(b) US EPA (2005).

(c) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(d) Based on the average food ingestion rate reported in US EPA (1993) of 0.032 g/g-day in wet weight. Converted to units of kg/day assuming a body weight of 2000 g (the smallest body weight used).

(e) Assumed 8.2% of dry food ingestion rate, where wet food ingestion rate was converted to dry food ingestion rate assuming 85% moisture content in berries and 49% moisture content in sedges (US EPA 1993).

(f) Concentration in poultry is equal to time in area x [(concentration in plants x poultry transfer factor x food ingestion rate) + (concentration in soil x poultry transfer factor x soil ingestion rate)]. Time in area is 0.33.

(g) In absence of a poultry transfer factor, the beef transfer factor was applied.

POPC = parameter of potential concern; SQRO = soil quality remediation objective; mg/kg = milligram per kilogram; ww = wet weight; day/kg ww = day per kilogram wet weight; kg dw/d = kilogram dry weight per day; PHC = petroleum hydrocarbon; NA = not applicable.

References:

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

Dauphine TC Jr. 1976. Biology of the Kaminuriak population of barren-ground caribou: Part 4. Report Series No. 38, Canadian Wildlife Service.

US EPA (United States Environmental Protection Agency). 1993. Wildlife Exposure Factor Handbook.

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

Table 2.12: Estimated Daily Intakes for Soil Direct Contact
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Soil Ingestion (mg/kg-d)	Dermal Contact with Soil (mg/kg-d)	Inhalation of Soil Particulates (mg/kg-d)	Total Estimated Daily Intake of Soil (mg/kg-d)
Threshold POPC - Adult				
Trichloroethylene	2.3E-04	6.0E-05	1.5E-07	2.9E-04
PHC F2 (C10-C16)	1.4E-02	2.4E-02	8.9E-06	3.8E-02
Aliphatic C10-C12	5.1E-03	8.7E-03	3.2E-06	1.4E-02
Aliphatic C12-C16	6.2E-03	1.1E-02	3.9E-06	1.7E-02
Aromatic C10-C12	1.3E-03	2.2E-03	8.0E-07	3.5E-03
Aromatic C12-C16	1.6E-03	2.7E-03	9.8E-07	4.2E-03
Methanol	4.2E-02	3.6E-01	2.6E-05	4.0E-01
Cyanide	2.2E-04	1.8E-04	1.4E-07	4.0E-04
Antimony	4.3E-05	3.7E-05	2.7E-08	8.0E-05
Arsenic	4.0E-05	2.0E-05	5.0E-08	6.0E-05
Barium	2.2E-02	1.8E-02	1.4E-05	4.0E-02
Beryllium	2.2E-04	1.8E-04	1.4E-07	4.0E-04
Cadmium	1.5E-04	1.3E-05	9.3E-08	1.6E-04
Chromium (VI)	2.4E-04	2.0E-04	1.5E-07	4.4E-04
Chromium (III)	1.6E-01	1.4E-01	1.0E-04	3.0E-01
Cobalt	1.8E-04	1.6E-05	1.2E-07	2.0E-04
Copper	5.6E-02	2.9E-02	3.6E-05	8.5E-02
Lead	4.6E-04	3.9E-05	4.8E-07	5.0E-04
Manganese	5.2E-04	4.5E-03	3.3E-07	5.0E-03
Mercury (inorganic)	3.3E-06	5.7E-05	4.2E-09	6.0E-05
Methylmercury	2.6E-05	1.4E-05	1.7E-08	4.0E-05
Molybdenum	9.2E-04	7.9E-05	5.8E-07	1.0E-03
Nickel	1.4E-03	1.0E-03	8.6E-07	2.4E-03
Selenium	1.1E-03	9.0E-05	6.6E-07	1.1E-03
Strontium	1.3E-02	1.1E-01	7.9E-06	1.2E-01
Thallium	2.5E-06	2.1E-07	1.6E-09	2.7E-06
Tin	1.3E-02	1.1E-01	7.9E-06	1.2E-01
Uranium	6.5E-05	5.5E-05	4.1E-08	1.2E-04
Vanadium	2.2E-04	1.9E-04	1.4E-07	4.2E-04
Zinc	6.2E-02	5.3E-02	3.9E-05	1.1E-01
Non-Threshold POPC - Adult				
Trichloroethylene	9.8E-03	2.5E-03	6.2E-06	1.2E-02
Arsenic	3.7E-06	1.9E-06	4.6E-09	5.6E-06

Notes:

Underlined POPC is associated with developmental effects and therefore a pregnant female is assessed.

POPC = parameter of potential concern; mg/kg-d = milligrams per kilogram per day; PHC = petroleum hydrocarbon.

Table 2.13: Estimated Daily Intakes for Consumption of Food
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Consumption of Berries (mg/kg-d)	Consumption of Caribou Meat (mg/kg-d)	Consumption of Caribou Kidney (mg/kg-d)	Consumption of Caribou Liver (mg/kg-d)	Consumption of Goose (mg/kg-d)
Threshold POPCs - Toddler or Pregnant Female (Developmental POPCs)					
Trichloroethylene	2.9E-04	2.9E-04	NC	NC	2.9E-04
PHC F2 (C10-C16)	NA	NA	NA	NA	NA
Aliphatic C10-C12	NA	NA	NA	NA	NA
Aliphatic C12-C16	NA	NA	NA	NA	NA
Aromatic C10-C12	NA	NA	NA	NA	NA
Aromatic C12-C16	NA	NA	NA	NA	NA
Methanol	4.0E-01	4.0E-01	NC	NC	4.0E-01
Cyanide	4.0E-04	4.0E-04	NC	NC	4.0E-04
Antimony	8.0E-05	8.0E-05	NC	NC	8.0E-05
Arsenic	6.0E-05	5.9E-05	1.9E-07	3.7E-07	6.0E-05
Barium	4.0E-02	4.0E-02	NC	NC	4.0E-02
Beryllium	4.0E-04	4.0E-04	NC	NC	4.0E-04
Cadmium	1.6E-04	4.1E-05	9.9E-05	2.1E-05	1.6E-04
Chromium (VI)	4.4E-04	4.4E-04	NC	NC	4.4E-04
Chromium (III)	3.0E-01	3.0E-01	3.1E-04	2.3E-04	3.0E-01
Cobalt	2.0E-04	1.9E-04	3.5E-06	8.2E-06	2.0E-04
Copper	8.5E-02	8.2E-02	4.4E-04	2.7E-03	8.5E-02
Lead	5.0E-04	4.9E-04	2.9E-06	2.9E-06	5.0E-04
Manganese	5.0E-03	4.7E-03	8.4E-05	2.2E-04	5.0E-03
Mercury (inorganic)	6.0E-05	4.1E-05	1.5E-05	3.4E-06	6.0E-05
Methylmercury	4.0E-05	3.9E-05	4.9E-07	2.5E-07	4.0E-05
Molybdenum	1.0E-03	6.9E-04	4.7E-05	2.7E-04	1.0E-03
Nickel	2.4E-03	2.4E-03	3.0E-07	6.0E-07	2.4E-03
Selenium	1.1E-03	1.1E-03	2.5E-05	1.3E-05	1.1E-03
Strontium	1.2E-01	1.2E-01	NC	NC	1.2E-01
Thallium	2.7E-06	2.7E-06	NC	NC	2.7E-06
Tin	1.2E-01	1.2E-01	NC	NC	1.2E-01
Uranium	1.2E-04	1.2E-04	NC	NC	1.2E-04
Vanadium	4.2E-04	4.2E-04	NC	NC	4.2E-04
Zinc	1.1E-01	1.1E-01	3.7E-04	3.8E-04	1.1E-01
Non-Threshold POPCs - Adult					
Trichloroethylene	1.2E-02	1.2E-02	NC	NC	1.3E-02
Arsenic	5.6E-06	5.5E-06	5.8E-09	1.2E-08	5.7E-06

Notes:

Underlined POPC is associated with developmental effects and therefore a pregnant female is assessed.

POPC = parameter of potential concern; mg/kg-d = milligrams per kilogram per day; NC = not calculated; PHC = petroleum hydrocarbon; NA = not applicable.

Table 2.14: Classification Systems for Non-Threshold Constituents
Meadowbank Complex Soil Quality Remediation Objectives

Health Canada	US EPA	IARC	Description
Group I	Group A	Group 1	Human carcinogen
Group II	Group B	Group 2A	Probable human carcinogen
--	Group B1	--	Limited human evidence available
--	Group B2	--	Inadequate human evidence, sufficient animal evidence
Group III	Group C	Group 2B	Possible human carcinogen
Group IV	--	--	Unlikely human carcinogen
Group VI	Group D	Group 3	Unclassifiable as to human carcinogenicity
Group V	Group E		Probably not carcinogenic to humans

Notes:

US EPA = United States Environmental Protection Agency; IARC = International Agency for Research on Cancer.

-- = Classification group not provided by agency.

Table 2.15: Classifications for Non-Threshold Parameters of Potential Concern
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Health Canada Classification[(a)]	US EPA Classification[(b)]	IARC Classification[(c)]	Assessed as a Non-Threshold POPC?
Trichloroethylene	Group 2	Group A	Group 1	**Yes**
PHC F2 (C10-C16)	NA	NA	NA	No
Methanol	NA	NA	NA	No
Cyanide	NA	Group D	NA	No
Antimony	NA	NA	NA	No
Arsenic	Group I	Group A	Group 1	**Yes**
Barium	NA	Group E	NA	No
Beryllium	NA	Group D	Group 1	**Yes (inhalation only)**
Cadmium	Group II	Group B1	Group 1	**Yes (inhalation only)**
Chromium (VI)	Group I	Group A	Group 1	**Yes (inhalation only)**
Chromium (III)	Group VI	Group D	Group 3	No
Cobalt	NA	NA	Group 2B	No
Copper	NA	Group D	NA	No
Lead	NA	Group B2	Group 2A	No
Manganese	NA	Group D	NA	No
Mercury (inorganic)	NA	Group D	Group 3	No
Methylmercury	NA	Group C	Group 2B	No
Molybdenum	NA	NA	NA	No
Nickel	Group 1	NA	Group 1	**Yes (inhalation only)**
Selenium	NA	Group D	Group 3	No
Strontium	NA	NA	NA	No
Thallium	NA	NA	NA	No
Tin	NA	NA	NA	No
Uranium	NA	NA	NA	No
Vanadium	NA	NA	NA	No
Zinc	NA	Group D	NA	No

Notes:

(a) Health Canada (2021).

(b) US EPA (2024).

(c) IARC (2024).

POPC = parameter of potential concern; US EPA = United States Environmental Protection Agency; IARC = International Agency for Research on Cancer; PHC = petroleum hydrocarbon; NA = not available;

References:

Health Canada. 2021. Federal Contaminated Site Risk Assessment in Canada: Toxicological Reference Values (TRVs) Version 3.0. March 2021.

IARC (International Agency for Research on Cancer). 2024. IARC Monographs on the Identification of Carcinogenic Hazards to Humans. Available online: https://monographs.iarc.fr/agents-classified-by-the-iarc/. Accessed May 2024.

US EPA (United States Environmental Protection Agency). 2024. Integrated Risk Information System (IRIS). National Center for Environmental Assessment, Office of Research and Development. Available Online: https://www.epa.gov/iris. Accessed May 2024.

Table 2.16: Oral Toxicity Reference Values
Meadowbank Complex Soil Quality Remediation Objectives

POPC	TDI (mg/kg/d)		Critical Effect	Study Duration	Principal Study	Reference	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Critical Effect	Study Duration	Principal Study	Reference
Trichloroethylene	0.00146	Developmental	Developmental toxicity (fetal heart defects)	Subchronic	HC 2005 (based on Dawson et al. 1993)	Health Canada 2021	0.000811	Kidney	Chronic	HC 2005 (based on NTP 1988 and NTP 1990)	Health Canada 2021
PHC F2 (C10-C16)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aliphatic C10-C12	0.1	NA	Hepatic and hematological changes	Chronic	TPHCWG (1997); CCME (2000)	MECP 2024	NA	NA	NA	NA	NA
Aliphatic C12-C16	0.1	NA	Hepatic and hematological changes	Chronic	TPHCWG (1997); CCME (2000)	MECP 2024	NA	NA	NA	NA	NA
Aromatic C10-C12	0.04	NA	Decreased body weight	Chronic	TPHCWG (1997); CCME (2000)	MECP 2024	NA	NA	NA	NA	NA
Aromatic C12-C16	0.04	NA	Decreased body weight	Chronic	TPHCWG (1997); CCME (2000)	MECP 2024	NA	NA	NA	NA	NA
Methanol	2	NA	Extra cervical ribs	Chronic	Rogers et al. 1993	US EPA IRIS 2013	NA	NA	NA	NA	NA
Cyanide	0.0020	NA	Decreased cauda epididymus weight in males	Chronic	mod US EPA IRIS 2010	MECP 2024	NA	NA	NA	NA	NA
Antimony	0.0004	NA	Longevity blood glucose and cholesterol	Chronic	US EPA IRIS (1991)	MECP 2024	NA	NA	NA	NA	NA
Arsenic	0.0003	NA	Hyperpigmentation keratosis possible vascular complications	Chronic	US EPA IRIS (1991)	MECP 2024	1.8	Bladder lung liver	Chronic	HC 2006 (based on Morales et al. 2000; Chen et al. 1985; Wu et al. 1989)	Health Canada 2021 and MECP 2024
Barium	0.2	NA	Nephrotoxicity (renal lesions)	Chronic	US EPA 2005a (based on NTP 1994)	Health Canada 2021	NA	NA	NA	NA	NA
Beryllium	0.002	NA	Gastrointestinal toxicity (lesions of the small intestine)	Chronic	US EPA 1998b (based on Morgareidge et al. 1976)	Health Canada 2021	NA	NA	NA	NA	NA
Cadmium	0.0008	NA	Nephrotoxicity (renal tubular dysfunction)	Chronic	WHO (2011)	Health Canada 2021	NA	NA	NA	NA	NA
Chromium (VI)	0.0022	NA	Gastrointestinal toxicity (diffuse epithelial hyperplasia of the small intestine)	Chronic	Health Canada 2016b (based on NTP 2008 Stout et al. 2009; Thompson et al. 2014; Summit Toxicology 2014)	Health Canada 2021	NA	NA	NA	NA	NA
Chromium (III)	1.5	NA	No effects observed	Chronic	US EPA 1998c (based on Ivankovic and Preussmann 1975)	Health Canada 2021	NA	NA	NA	NA	NA
Cobalt	0.001	NA	Polycythemia (disease state in which the volume percentage of red blood cells in the blood is elevated)	Chronic	Modified from ATSDR (2004)	MECP 2024	NA	NA	NA	NA	NA

Table 2.16: Oral Toxicity Reference Values
Meadowbank Complex Soil Quality Remediation Objectives

POPC	TDI (mg/kg/d)		Critical Effect	Study Duration	Principal Study	Reference	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Critical Effect	Study Duration	Principal Study	Reference
Copper	0.426	NA	Gastrointestinal toxicity and Hepatotoxicity (liver function).	Subchronic (exposure during infant life stage)	HC 2019a (based on Olivares et al. 1998)	Health Canada 2021	NA	NA	NA	NA	NA
Lead	0.0005	Developmental	Neuro-developmental toxicity (cognitive function) including fetal development	Chronic	EFSA 2013 (based on Lanphear et al. 2005)	Health Canada 2021	NA	NA	NA	NA	NA
Manganese	0.025	NA	Neuro-developmental toxicity	Chronic	HC 2019b (based on Kern et al. 2010 Kern and Smith 2011 and Beaudin et al. 2013)	Health Canada 2021	NA	NA	NA	NA	NA
Mercury (inorganic)	0.0003	NA	Immunotoxicity (autoimmune glomerulonephritis)	Subchronic to Chronic extrapolation	CCME 1999ab and US EPA 1995b (based on Druet et al. 1978; Bernaudin et al. 1981; Andres 1984)	Health Canada 2021	NA	NA	NA	NA	NA
Methylmercury	0.0002	Developmental	Neuro-developmental toxicity	Chronic	HC 2007 (based on Grandjean et al. 1997)	Health Canada 2021	NA	NA	NA	NA	NA
Molybdenum	0.005	NA	Increased uric acid levels	Chronic	US EPA IRIS 1993	MECP 2024	NA	NA	NA	NA	NA
Nickel	0.012	TRV for nickel sulfate was chosen as this is the same nickel compound used in the derivation of the generic CCME SQG	Reproductive toxicity (perinatal death)	Chronic	HC 1996 (based on Smith et al. 1993)	Health Canada 2021	NA	NA	NA	NA	NA
Selenium	0.0057	(>20 yrs)	Hair and nail brittleness and loss (signs and symptoms of chronic selenosis)	Chronic	IOM 2000 (based on Yang and Zhou 1994; Shearer and Hadjimarkos 1975)	Health Canada 2021	NA	NA	NA	NA	NA
Strontium	0.6	NA	Rachitic bone	Chronic	Storey 1961; Marie et al.1985; Skoryna 1981	US EPA IRIS 1992	NA	NA	NA	NA	NA
Thallium	0.0000135	NA	Alopecia and liver damage	Subchronic	CalEPA DW (1999)	MECP 2024	NA	NA	NA	NA	NA
Tin	0.6	NA	Kidney and liver lesions	Chronic	NTP (1982); US EPA (1986); US EPA (1987)	HEAST 2019	NA	NA	NA	NA	NA
Uranium	0.0006	NA	Nephrotoxicity (renal lesions)	Subchronic/ Chronic	HC 2019c (based on Gilman et al. 1998)	Health Canada 2021	NA	NA	NA	NA	NA

Table 2.16: Oral Toxicity Reference Values
Meadowbank Complex Soil Quality Remediation Objectives

POPC	TDI (mg/kg/d)		Critical Effect	Study Duration	Principal Study	Reference	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Critical Effect	Study Duration	Principal Study	Reference
Vanadium	0.0021	Developmental	Developmental effects	Chronic	CalEPA DW (2000)	MECP 2024	NA	NA	NA	NA	NA
Zinc	0.57	(20+ yrs)	Decrease in erythrocyte superoxide dismutase (ESOD) activity	Chronic	IOM 2001 (based on Yadrick et al. 1989 and Walravens and Hambidge 1976)	Health Canada 2021	NA	NA	NA	NA	NA

Notes:

POPC = parameter of potential concern; TDI = tolerable daily intake; TRV = toxicity reference value; mg/kg-d = milligrams per kilogram per day; PHC = petroleum hydrocarbon; NA = not applicable; yrs = years; CCME SQG = Canadian Council of Ministers of the Environment Soil Quality Guideline.

References:

Health Canada. 2021. Federal Contaminated Site Risk Assessment In Canada: Health Canada Toxicological Reference Values (TRVs).

MECP (Ontario Ministry of Environment Conservation and Parks). 2024. Human Health Toxicity Reference Values. March 2024.

HEAST (Health Effects Assessment Summary Tables). 2019. Oak Ridge National Laboratory. Accessed August 2019. Available at: https://epa-heast.ornl.gov/heast.php

US EPA (United States Environmental Protection Agency). 1992. Integrated Risk Information System (IRIS) - Strontium. Available at: https://iris.epa.gov/ChemicalLanding/&substance_nmbr=550

US EPA. 2013. Integrated Risk Information System (IRIS) - Methanol. Available at: https://iris.epa.gov/ChemicalLanding/&substance_nmbr=305

Table 2.17: Non-Threshold Inhalation Toxicity Reference Values
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Inhalation Unit Risk $(mg/m^3)^{-1}$	Critical Effect	Study Duration	Principal Study	Reference
Trichloroethylene (1,1,2-Trichloroethene)	4.10E-03	Cancer (liver, kidney [renal cell carcinoma], non-Hodgkin's lymphoma)	Chronic	US EPA 2011b (based on Charbotel et al. 2006 and Raaschou-Nielsen et al. 2003)	Health Canada 2021
PHC F2 (C10-C16)	NV	NA	NA	NA	NA
Aliphatic C10-C12	NV	NA	NA	NA	NA
Aliphatic C12-C16	NV	NA	NA	NA	NA
Aromatic C10-C12	NV	NA	NA	NA	NA
Aromatic C12-C16	NV	NA	NA	NA	NA
Methanol	NV	NA	NA	NA	NA
Cyanide	NV	NA	NA	NA	NA
Antimony	NV	NA	NA	NA	NA
Arsenic	6.4	Lung Cancer	Chronic	HC/EC 1993a (based on Higgins et al. 1986)	Health Canada 2021
Barium	NV	NA	NA	NA	NA
Beryllium	2.4	Lung Cancer	Chronic	US EPA 1998b (based on Wagoner et al. 1980; NIOSH 1972)	Health Canada 2021
Cadmium	4.2	Lung Cancer	Chronic	OEHHA 2011 (based on Thun et al. 1985 1986; CDHS 1986; CDHS 1990	Health Canada 2021
Chromium (VI)	7.6E+01	Lung Cancer	Chronic	HC 1996a (based on Mancuso 1975)	Health Canada 2021
Chromium (III)	NV	NA	NA	NA	NA
Cobalt	NV	NA	NA	NA	NA
Copper	NV	NA	NA	NA	NA
Lead	NV	NA	NA	NA	NA
Manganese	NV	NA	NA	NA	NA
Mercury (Inorganic)	NV	NA	NA	NA	NA
Methylmercury	NV	NA	NA	NA	NA
Molybdenum	NV	NA	NA	NA	NA
Nickel	1.30	Respiratory effects, morphological and biological effects	Subchronic	EC and HC 1994e and HC 1996 (based on Johansson et al. 1983)	Health Canada 2021
Strontium	NV	NA	NA	NA	NA
Thallium	NV	NA	NA	NA	NA
Tin	NV	NA	NA	NA	NA
Uranium	NV	NA	NA	NA	NA
Vanadium	NV	NA	NA	NA	NA

Notes:
POPC = parameter of potential concern; $(mg/m^3)^{-1}$ = per milligram per cubic metres; NV = no value; NA = not applicable.

References:
Health Canada. 2021. Federal Contaminated Site Risk Assessment In Canada: Part II: Health Canada Toxicological Reference Values (TRVs).
MECP (Ontario Ministry of Environment, Conservation and Parks). 2024. Human Health Toxicity Reference Values. March 2024.

Table 2.18: Soil Quality Remediation Objectives for Protection of Inhalation of Soil Particulates - with TRV expressed as an Inhalation Unit Risk
Meadowbank Complex Soil Quality Remediation Objectives

POPC [(a)]	SQRO (mg/kg)	Inhalation of Soil Particulates (mg/m^3)	ILCR
Beryllium	32100000	4.2E-06	1.0E-05
Cadmium	18300000	2.4E-06	1.0E-05
Chromium (VI)	1012000	1.3E-07	1.0E-05
Nickel	59300000	7.7E-06	1.0E-05

Notes:

POPC = parameter of potential concern; SQRO = soil quality remediation objective; mg/kg = milligram per kilogram; TRV = toxicity reference value; ILCR = incremental lifetime cancer risk

(a) Only POPCs associated with non-threshold effects through the inhalation pathway (i.e., where an inhalation unit risk are available) are presented.

Table 3.1: Soil Quality Remediation Objectives (SQROs) for Ecological Health
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Terrestrial Plants and Soil Organisms	Wildlife				Ecological Health SQRO[(a)]
	Direct Contact	Northern Red-Backed Vole	Caribou	Lapland Longspur	Canada Goose	
Trichloroethylene	**3**	80	1310	14	76796	3
PHC F2 (C10-C16)	**150**	37275	286731	21769	1386364	150
Methanol	1200	**647**	9093	660	2559124	647
Cyanide	0.9	177	2499	**0.50**	7	0.50
Antimony	**5**	46175	262077	264	107226	5
Arsenic	**17**	971	8027	954	82049	17
Barium	**330**	14002	126456	4431	464215	330
Beryllium	10	268	4084	**8.4**	316	8.4
Cadmium	**10**	7992	64084	2403	221753	10
Chromium	**64**	6923	80244	267	41973	64
Cobalt	**13**	1363	12749	458	46785	13
Copper	**63**	12230	96560	9979	687308	63
Lead	**300**	24103	404802	1272	46752	300
Manganese	**220**	230222	1819626	158959	10832950	220
Mercury (inorganic)	**12**	76	4727	92	712	12
Methylmercury	0.8	2	42	**0.20**	139	0.20
Molybdenum	**2**	46	1051	349	8792	2
Nickel	**45**	64665	511591	16385	1185313	45
Selenium	**1**	23	228	28	615	1
Strontium	NV	199876	1671040	**2740**	287908	2740
Thallium	**1.4**	31	461	53	4123	1.4
Tin	**50**	9565	137864	384	86797	50
Uranium	**500**	4810	16545	2295	171431	500
Vanadium	**130**	632	3090	1188	48004	130
Zinc	**250**	264744	2051106	18182	1452167	250

Notes:

Bold and Shaded indicates that the overall Ecological Health SQRO is based on this exposure pathway

All units in milligrams per kilogram dry weight (mg/kg dw).

(a) Ecological Health SQRO is the minimum of the pathway-specific SQROs.

POPC = parameter of potential concern; SQRO = soil quality remediation objective; NV = no value

Table 3.2: Receptor Characteristics for Terrestrial Mammals and Birds
Meadowbank Complex Soil Quality Remediation Objectives

Receptor Characteristic	Units	Northern Red-Backed Vole	Caribou	Lapland Longspur	Canada Goose
Body Weight	kg wet	0.02	75	0.023	2
Soil Ingestion Rate	kg dry/kg wet/day	0.0012	0.0013	0.0174	0.0009
Soil Ingestion Rate [a]	kg dry/day	0.000024	0.098	0.00040	0.00055
Food Ingestion Rate [b]	kg wet/kg wet/day	0.135	0.042	1.0	0.032
Food Ingestion Rate [c]	kg wet/day	0.0027	3.1	0.023	0.064
Food Ingestion Rate	kg dry/kg wet/day	0.049	0.027	0.249	0.011
Proportion of Diet[d]					
Sedges		0.55	0.3	0.25	0.5
Lichens		0	0.65	0	0
Berries		0.4	0.05	0.05	0.5
Insects		0.05	0	0.7	0
Food		1	1	1	1
Time in Area		1	0.12	0.33	0.33

Notes:

Receptor characteristics adopted from the Wildlife and HHRA Country Foods Screening Level Risk Assessment Plan Version 9 (2024), unless noted otherwise.

[a] Converted to kg dry/day for use in calculations by multiplying by body weight (kg wet).

[b] Food ingestion rates for caribou and longspur were converted to wet food intake assuming site specific moisture content as follows:
35% for caribou diet (calculated from 30% sedges at 49% moisture, 65% lichens at 24% moisture, and 5% berries at 85% moisture)
75% for longspur diet (calculated from 25% sedges at 49%, 5% berries and 70% insects at 84% moisture [Sample and Suter 1994])
Food intakes for vole and goose were not adjusted to be site specific as the original sources were already provided in wet weight.

[c] Converted to kg wet/day for use in calculations by dividing by body weight (kg wet).

[d] The diet for the Canada Goose was assumed to be 50% sedges and 50% berries. See text for further discussion.

L = litres; kg wet = kilogram wet weight; kg dw/d = kilogram dry weight per day; km^2 = square kilometre

Table 3.3: Predicted Concentrations of POPCs in Plants - Berries
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Site-Specific BAF or Literature Uptake Factor		Calculated Concentrations in Berries - Vole (mg/kg ww)	Calculated Concentrations in Berries - Caribou (mg/kg ww)	Calculated Concentrations in Berries - Longspur (mg/kg ww)	Calculated Concentrations in Berries - Goose (mg/kg ww)
Trichloroethylene	Cp = 1.59 × Cs	(d,e)	1.92E+01	3.12E+02	3.26E+00	1.83E+04
PHC F2 (C10-C16)	NA	(f)	NA	NA	NA	NA
Methanol	Cp = 8.38 × Cs	(d,e)	8.13E+02	1.14E+04	8.29E+02	3.22E+06
Cyanide	Cp = 8.38 × Cs	(d,e)	2.23E+02	3.14E+03	6.28E-01	9.01E+00
Antimony	$\ln(C_p) = 0.938 \times \ln(C_s) - 3.233$	(g,e)	1.40E+02	7.15E+02	1.11E+00	3.09E+02
Arsenic	LogBAF = -0.8334xLogSoil -1.8954	(b)	4.00E-02	5.69E-02	3.99E-02	8.38E-02
Barium	LogBAF = -1.077xLogSoil + 0.1163	(b)	6.27E-01	5.29E-01	6.85E-01	4.79E-01
Beryllium	Cp = 0.0224 x Cs	(b)	6.01E+00	9.15E+01	1.88E-01	7.09E+00
Cadmium	LogBAF = -1.2121xLogSoil - 2.592	(b)	3.80E-04	2.45E-04	4.91E-04	1.88E-04
Chromium	Cp = 0.0053 x Cs	(b)	3.67E+01	4.25E+02	1.42E+00	2.22E+02
Cobalt	Cp = 0.0021 x Cs	(b)	2.86E+00	2.68E+01	9.61E-01	9.82E+01
Copper	LogBAF = -1.037xLogSoil - 0.1178	(b)	5.38E-01	4.99E-01	5.42E-01	4.64E-01
Lead	Cp = 0.0011 x Cs	(b)	2.65E+01	4.45E+02	1.40E+00	5.14E+01
Manganese	LogBAF = -1.0813xLogSoil + 1.1339	(b)	4.99E+00	4.22E+00	5.14E+00	3.65E+00
Mercury (inorganic)	Cp = 0.2222 × Cs	(a)	1.68E+01	1.05E+03	2.05E+01	1.58E+02
Methylmercury	Cp = 0.137 × Cs	(c,e)	2.06E-02	2.06E-02	9.25E-03	9.25E-03
Molybdenum	Cp = 0.0179 x Cs	(b)	8.16E-01	1.88E+01	6.25E+00	1.57E+02
Nickel	LogBAF = -0.7535xLogSoil - 0.863	(b)	2.10E+00	3.50E+00	1.50E+00	4.31E+00
Selenium	ln(Cp) = 1.104 × ln(Cs) - 0.677	(g,e)	2.37E+00	3.06E+01	3.06E+00	9.15E+01
Strontium	LogBAF = -0.8123xLogSoil - 0.6504	(b)	2.21E+00	3.29E+00	9.88E-01	2.37E+00
Thallium	Cp = 0.0177 x Cs	(b)	5.46E-01	8.16E+00	9.46E-01	7.30E+01
Tin	Cp = 0.03 x Cs	(h,e)	4.30E+01	6.20E+02	1.73E+00	3.91E+02
Uranium	Cp = 0.0006 x Cs	(b)	2.89E+00	9.93E+00	1.38E+00	1.03E+02
Vanadium	LogBAF = -0.9559xLogSoil -1.4733	(b)	4.47E-02	4.79E-02	4.60E-02	5.41E-02
Zinc	LogBAF = -1.1207xLogSoil + 0.2818	(b)	4.24E-01	3.31E-01	5.86E-01	3.45E-01

Notes:

(a) Adopted site-specific BAF for total mercury.

(b) Site-specific BAF presented in wet weight.

(c) US EPA (1999) Soil to plant bioconcentration factor.

(d) US EPA (2005). Uptake factors for above ground produce applied.

(e) Converted to wet weight assuming a moisture content of 85% in berries based on site-specific average tissue moisture content.

(f) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(g) US EPA (2007). Soil to Plants Uptake Equation.

(h) Baes et al. (1984). Soil to plant concentration factor.

POPC = parameter of potential concern; BAF = bioaccumulation factor; mg/kg ww = milligrams per kilogram wet weight; Cp = concentration in plants; Cs = concentration in soil; SQRO = soil quality remediation objective; NA = not applicable.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide.

US EPA (United States Environmental Protection Agency). 1999. Appendix C: Media to Receptor Bioconcentration Factors (BCFs). Screening Level Ecological Risk Assessment Protocol. August 1999.

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

US EPA. 2007. Guidance for Developing Ecological Soil Screening Levels
(Eco-SSL). Attachment 4-1. OSWER Directive 9285.7-55. Table 4a. Uptake Equations for Inorganics. Revised April 2007.

Table 3.4: Predicted Concentrations of POPCs in Plants - Lichens
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Site-Specific BAF or Literature Uptake Factor		Calculated EPC in Lichens - Vole (mg/kg ww)	Calculated EPC in Lichens - Caribou (mg/kg ww)	Calculated EPC in Lichens - Longspur (mg/kg ww)	Calculated EPC in Lichens - Goose (mg/kg ww)
Trichloroethylene	Cp = 1.59 × Cs	(d,e)	NA	1.58E+03	NA	NA
PHC F2 (C10-C16)	NA	(f)	-	-	-	-
Methanol	Cp = 8.38 × Cs	(d,e)	NA	5.79E+04	NA	NA
Cyanide	Cp = 8.38 × Cs	(d,e)	NA	1.59E+04	NA	NA
Antimony	Cp = 0.0846*Cs	(b)	NA	2.22E+04	NA	NA
Arsenic	LogBAF = -0.9725xLogSoil + 0.2228	(b)	NA	2.14E+00	NA	NA
Barium	LogBAF = -1.0445xLogSoil + 1.2703	(b)	NA	1.10E+01	NA	NA
Beryllium	LogBAF = -1.3035xLogSoil -1.5339	(b)	NA	2.34E-03	NA	NA
Cadmium	LogBAF = -0.8643xLogSoil -0.93	(b)	NA	5.28E-01	NA	NA
Chromium	LogBAF = -0.7526xLogSoil + 0.9415	(b)	NA	1.43E+02	NA	NA
Cobalt	LogBAF = -0.9834xLogSoil -0.0094	(b)	NA	1.14E+00	NA	NA
Copper	LogBAF = -0.8585xLogSoil + 0.2635	(b)	NA	9.31E+00	NA	NA
Lead	LogBAF = -0.8385xLogSoil + 0.0921	(b)	NA	9.95E+00	NA	NA
Manganese	LogBAF = -1.2203xLogSoil + 2.5976	(b)	NA	1.65E+01	NA	NA
Mercury (inorganic)	LogBAF = -0.9065xLogSoil - 0.9254	(a)	NA	2.62E-01	NA	NA
Methylmercury	Cp = 0.137 × Cs	(c,e)	NA	4.35E+00	NA	NA
Molybdenum	Cp = 0.3792*Cs	(b)	NA	3.99E+02	NA	NA
Nickel	LogBAF = -0.8168xLogSoil + 0.6597	(b)	NA	5.08E+01	NA	NA
Selenium	Cp = 0.3097*Cs	(b)	NA	7.08E+01	NA	NA
Strontium	LogBAF = -0.6418xLogSoil + 0.5956	(b)	NA	6.68E+02	NA	NA
Thallium	LogBAF = -1.0062xLogSoil -1.7902	(b)	NA	1.56E-02	NA	NA
Tin	Cp = 0.03 x Cs	(g,e)	NA	3.14E+03	NA	NA
Uranium	Cp = 0.0656*Cs	(b)	NA	1.09E+03	NA	NA
Vanadium	Cp = 0.1487*Cs	(b)	NA	4.60E+02	NA	NA
Zinc	LogBAF = -1.1591xLogSoil + 1.4446	(b)	NA	2.76E+00	NA	NA

Notes:

(a) Adopted site-specific BAF for total mercury.

(b) Site-specific BAF in wet weight.

(c) US EPA (1999). Soil to plant bioconcentration factor.

(d) US EPA (2005). Uptake factors for above ground produce applied.

(e) Converted to wet weight assuming a moisture content of 24% in lichens based on site-specific average tissue moisture content.

(f) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(g) Baes et al. (1984). Soil to plant concentration factor.

(h) Adopted site-specific BAF for total mercury.

POPC = parameter of potential concern; BAF = bioaccumulation factor; mg/kg ww = milligrams per kilogram wet weight; Cp = concentration in plants; Cs = concentration in soil; SQRO = soil quality remediation objective; NA = not applicable.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide

US EPA (United States Environmental Protection Agency). 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities Peer Review Draft, November 1999. Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs). August 1999.

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

Table 3.5: Predicted Concentrations of POPCs in Plants - Sedges
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Site-Specific BAF or Literature Uptake Factor		Calculated EPC in Sedges - Vole (mg/kg ww)	Calculated EPC in Sedges - Caribou (mg/kg ww)	Calculated EPC in Sedges - Longspur (mg/kg ww)	Calculated EPC in Sedges - Goose (mg/kg ww)
Trichloroethylene	Cp = 1.59 × Cs	(d,e)	6.52E+01	1.06E+03	1.11E+01	6.23E+04
PHC F2 (C10-C16)	NA	(f)	-	-	-	-
Methanol	Cp = 8.38 × Cs	(d,e)	2.77E+03	3.89E+04	2.82E+03	1.09E+07
Cyanide	Cp = 8.38 × Cs	(d,e)	7.57E+02	1.07E+04	2.13E+00	3.06E+01
Antimony	LogBAF = -1.5097xLogSoil - 2.7317	(b)	7.78E-06	3.21E-06	1.08E-04	5.06E-06
Arsenic	LogBAF = -0.9197xLogSoil -0.5449	(b)	4.95E-01	5.87E-01	4.95E-01	7.07E-01
Barium	LogBAF = -0.9354xLogSoil + 1.0621	(b)	2.14E+01	2.46E+01	1.98E+01	2.68E+01
Beryllium	LogBAF = -1.0447xLogSoil - 2.0231	(b)	7.38E-03	6.54E-03	8.62E-03	7.33E-03
Cadmium	LogBAF = -0.7288xLogSoil -1.4038	(b)	4.51E-01	7.94E-01	3.26E-01	1.11E+00
Chromium	LogBAF = -0.9028xLogSoil + 0.4676	(b)	6.93E+00	8.80E+00	5.05E+00	8.26E+00
Cobalt	LogBAF = -0.9153xLogSoil - 0.6554	(b)	4.07E-01	4.92E-01	3.72E-01	5.50E-01
Copper	LogBAF = -0.8988xLogSoil + 0.1111	(b)	3.35E+00	4.13E+00	3.28E+00	5.03E+00
Lead	Cp = 0.0276 x Cs	(b)	6.65E+02	1.12E+04	3.51E+01	1.29E+03
Manganese	LogBAF = -1.1129xLogSoil + 2.4588	(b)	7.14E+01	5.65E+01	7.44E+01	4.62E+01
Mercury (inorganic)	LogBAF = -1.0808xLogSoil - 2.2306	(a)	4.15E-03	2.97E-03	4.08E-03	3.46E-03
Methylmercury	Cp = 0.137 × Cs	(c,e)	1.07E-01	2.92E+00	1.37E-02	9.73E+00
Molybdenum	Cp = 0.7254 x Cs	(b)	3.31E+01	7.62E+02	2.53E+02	6.38E+03
Nickel	LogBAF = -0.8261xLogSoil + 0.2413	(b)	1.20E+01	1.71E+01	9.42E+00	1.98E+01
Selenium	Cp = 0.0806 x Cs	(b)	1.82E+00	1.84E+01	2.29E+00	4.96E+01
Strontium	LogBAF = -0.7679xLogSoil + 0.527	(b)	5.72E+01	9.36E+01	2.11E+01	6.22E+01
Thallium	LogBAF = -1.0826xLogSoil -2.6017	(b)	1.88E-03	1.51E-03	1.80E-03	1.26E-03
Tin	Cp = 0.03 x Cs	(g,e)	1.46E+02	2.11E+03	5.87E+00	1.33E+03
Uranium	LogBAF = -1.1471xLogSoil -1.5002	(b)	9.08E-03	7.57E-03	1.01E-02	5.37E-03
Vanadium	Cp = 0.0279 x Cs	(b)	1.76E+01	8.62E+01	3.31E+01	1.34E+03
Zinc	LogBAF = -1.0115xLogSoil + 1.163	(b)	1.26E+01	1.23E+01	1.30E+01	1.24E+01

Notes:

(a) Adopted site-specific BAF for total mercury.

(b) Site-specific BAF based on wet weight.

(c) US EPA (1999). Soil to plant bioconcentration factor.

(d) US EPA (2005). Uptake factors for above ground produce applied.

(e) Converted to wet weight assuming a moisture content of 49% in sedges based on site-specific average tissue moisture content.

(f) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that plant uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(g) Baes et al. (1984). Soil to plant concentration factor.

POPC = parameter of potential concern; BAF = bioaccumulation factor; mg/kg dw = milligrams per kilogram dry weight; Cp = concentration in sedges; Cs = concentration in soil; SQRO = soil quality remediation objective; NA = not applicable; BAF = bioaccumulation factor.

References:

Baes III CF, Sharp RD, Sjoreen AL, Shor RW. 1984. Review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture (No. ORNL-5786). Oak Ridge National Lab., TN (USA). Soil-to-plant elemental transfer coefficient for vegetative portions of food crops and feed berries.

CCME (Canadian Council of Ministers of the Environment). 2008. Canadian Wide Standards for Petroleum Hydrocarbons: User Guide

US EPA (United States Environmental Protection Agency). 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities Peer Review Draft, November 1999. Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs). August 1999.

US EPA. 2005. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities.

Table 3.6: Predicted Concentrations of POPCs in Insects
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Literature Uptake Factor		Calculated EPC in Insects - Vole (mg/kg ww)	Calculated EPC in Insects - Caribou (mg/kg ww)	Calculated EPC in Insects - Longspur (mg/kg ww)	Calculated EPC in Insects - Goose (mg/kg ww)
Trichloroethylene	$Ce=11.77*Cs$	(j,e)	1.52E+02	NA	2.58E+01	NA
PHC F2 (C10-C16)	--	(a)	--	--	--	--
Methanol	$Ce = 0$	(d)	0.00E+00	NA	0.00E+00	NA
Cyanide	$Ce = 1.12 * Cs$	(f,e)	3.18E+01	NA	8.95E-02	NA
Antimony	$C_e = C_s$	(c,e)	7.39E+03	NA	4.23E+01	NA
Arsenic	$\ln(C_e) = 0.93 * \ln(C_s) -2.450$	(b,e)	8.28E+00	NA	8.15E+00	NA
Barium	$C_e = 0.091 * C_s$	(c,e)	2.04E+02	NA	6.45E+01	NA
Beryllium	$C_e = 0.045 * C_s$	(c,e)	1.93E+00	NA	6.05E-02	NA
Cadmium	$\ln(C_e) = 0.610 * \ln(C_s) + 0.370$	(b,e)	5.56E+01	NA	2.67E+01	NA
Chromium	$C_e = 0.306 * C_s$	(c,e)	3.39E+02	NA	1.31E+01	NA
Cobalt	$C_e = 0.122 * C_s$	(c,e)	2.66E+01	NA	8.94E+00	NA
Copper	$\ln(C_e) = 0.310 * \ln(C_s) + 1.920$	(b,e)	2.02E+01	NA	1.90E+01	NA
Lead	$\ln(C_e) = 0.700 * \ln(C_s) -1.630$	(b,e)	3.66E+01	NA	4.67E+00	NA
Manganese	$\ln(C_e) = 0.682 * \ln(C_s) - 0.809$	(c,e)	3.23E+02	NA	2.51E+02	NA
Mercury (inorganic)	$\ln(C_e)=0.12*\ln(C_s)-0.68$	(g,e)	1.36E-01	NA	1.39E-01	NA
Methylmercury	$Ce = 8.5 * Cs$	(f,e)	2.09E+00	NA	2.67E-01	NA
Molybdenum	$Ce=0.953*Cs$	(h,e)	6.95E+00	NA	5.32E+01	NA
Nickel	$Ce = 0.02 * Cs$	(f,e)	2.07E+02	NA	5.24E+01	NA
Selenium	$\ln(C_e) = 0.733 * \ln(C_s) - 0.075$	(c,e)	1.46E+00	NA	1.72E+00	NA
Strontium	$C_e=0.087*C_s$	(h,e)	2.78E+03	NA	3.81E+01	NA
Thallium	$Ce = 0.22 * Cs$	(f,e)	1.09E+00	NA	1.88E+00	NA
Tin	$C_e = C_s$	(i,e)	1.53E+03	NA	6.14E+01	NA
Uranium	$C_e=0.033*C_s$	(h,e)	2.54E+01	NA	1.21E+01	NA
Vanadium	$C_e = 0.042 * C_s$	(c,e)	4.25E+00	NA	7.98E+00	NA
Zinc	$\ln(C_e) = 0.220 * \ln(C_s) + 4.380$	(b,e)	1.99E+02	NA	1.11E+02	NA

Notes:

(a) There are insufficient data to evaluate PHC exposure through the food chain. The few data available suggest that soil invertebrate uptake of PHC and subsequent exposure at higher trophic levels is not a concern (CCME 2008).

(b) Bioaccumulation models for arsenic, cadmium, copper, lead and zinc were consistent with the Wildlife and Human Health Country Foods Screening Level RIsk Assessment (WCFSLRA). For other metals, rather than assume a BAF of 1 as was done in the WCFSLRA, other literature sources of bioaccumulation models were used if available.

(c) US EPA (2007). Soil to Earthworms Uptake Equation.

(d) Based on its very low log Kow (i.e., -0.77), methanol is not expected to accumulate into insect tissues to any significant extent. Concentrations in insects were assumed to be negligible.

(e) Converted to wet weight assuming a moisture content of 84% in insects (earthworms) based on percent water contents provided in Sample and Suter (1994).

(f) US EPA (1999). Soil to soil invertebrate bioconcentration factor.

(g) Adopted literature uptake factor for total mercury. Simple regression on combined model and validation data sets; Sample et al. (1999).

(h) Median uptake factor; Sample et al. (1998).

(i) No bioaccumulation model was available, therefore a BAF of 1 was assumed.

(j) Modelled from Kow based on Jager (1998, as cited in US EPA 2007).

POPC = parameter of potential concern; mg/kg ww = milligrams per kilogram wet weight; Ce = concentration in earthworms; Cs = concentration in soil; EPC = Exposure Point Concentration; NA = not applicable (receptor does not consume insects).

References:

CCME (Canadian Council of Ministers of the Environment). 2008. Canada-Wide Standards for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale. Supporting Technical Document.

Sample BE and Suter GW. 1994. Estimating Exposure of Terrestrial Wildlife to Contaminants. ES/ER/TM-125. September 1994.

Sample BE, Beauchamp JJ, Efroymson RA, Suter II GW. 1998. Development and Validation of Bioaccumulation Models for Small Mammals. Prepared for the US Department of Energy, Office of Environmental Management. ES/ER/TM-219. February 1998.

Sample BE, Suter II GW, Beauchamp JJ, Efroymson A. 1999. Literature Derived Bioaccumulation Models for Earthworms: Development and Validation. Environmental Toxicology and Chemistry, 18(9): 2110-2120.

US EPA (United States Environmental Protection Agency). 1999. Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities Peer Review Draft, November 1999. Appendix C: Media-to-Receptor Bioconcentration Factors (BCFs). August 1999.

US EPA . 2007. Ecological Soil Screening Levels. Guidance for Developing Ecological Soil Screening Levels (Eco-SSL), Attachment 4-1. OSWER Directive 9285.7-55.

Table 3.7: Toxicity Reference Values for Terrestrial Plants and Soil Invertebrates in Soil
Meadowbank Complex Soil Quality Remediation Objectives

POPC	TRV for Plants and Soil Invertebrates (mg/kg)	Reference	Source
Trichloroethylene	3	CCME 1999 and updates	CCME 2006 (soil contact)
PHC F2 (C10-C16)	150	CCME 2008	CCME 2008 (ecological direct soil contact)
Methanol	1,200	CCME 1999 and updates	CCME 2017 (soil contact)
Cyanide	0.9	CCME 1999 and updates	CCME 1997a (soil contact)
Antimony	5	Efroymson 1997	-
Arsenic	17	CCME 1999 and updates	CCME 1997b (soil contact)
Barium	330	US EPA 2024	Eco-SSL for soil invertebrates
Beryllium	10	Efroymson 1997	-
Cadmium	10	CCME 1999 and updates	CCME 1999a (soil contact)
Chromium (Total)	64	CCME 1999 and updates	CCME 1997c (soil contact)
Cobalt	13	US EPA 2024	Eco-SSL for terrestrial plants
Copper	63	CCME 1999 and updates	CCME 1999b (soil contact)
Lead	300	CCME 1999 and updates	CCME 1999c (soil contact)
Manganese	220	US EPA 2024	Eco-SSL for terrestrial plants
Mercury (inorganic)	12	CCME 1999 and updates	CCME 1999d (soil contact)
Methylmercury	0.8	MOECC 2016	Plants and soil organisms component value
Molybdenum	2	Efroymson 1997	-
Nickel	45	CCME 1999 and updates	CCME 2015 (soil contact)
Selenium	1	CCME 1999 and updates	CCME 2009 (soil contact)
Strontium	NV	-	-
Thallium	1.4	CCME 1999 and updates	CCME 1999e (soil contact)
Tin	50	Efroymson 1997	-
Uranium	500	CCME 1999 and updates	CCME 2007 (soil contact)
Vanadium	130	CCME 1999 and updates	CCME 1997d (soil contact)
Zinc	250	CCME 1999 and updates	CCME 2018 (soil contact)

Notes:

POPC = parameter of potential concern; mg/kg = milligrams per kilogram; CCME = Canadian Council of Ministers of the Environment; TRV = toxicity reference value; NV = no value.

References:

CCME (Canadian Council of Ministers of the Environment). 1999 and updates to 2024. Canadian Soil Quality Guidelines for the Protection of Environmental Health (SQG_E), agricultural land use, coarse textured soil, surface soil. https://ccme.ca/en/resources/soil-and-groundwater (June 2024).

CCME. 1997a. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Cyanide (Free).

CCME. 1997b. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Arsenic (Inorganic).

CCME. 1997c. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Chromium (Total).

CCME. 1997d. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Vanadium.

CCME. 1999a. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Cadmium.

CCME. 1999b. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Copper.

CCME. 1999c. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Lead.

CCME. 1999d. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Mercury (Inorganic).

CCME. 1999e. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Thallium.

CCME. 2006. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Trichloroethylene.

CCME. 2007. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Uranium.

CCME. 2008. Canadian-Wide Standards (CWS) for Petroleum Hydrocarbons (PHCs) in Soil: Scientific Rationale. Supporting Technical Document. January 2008. Table 5.2 and 5.3 Tier 1 Levels for PHC, agricultural land use, applicable to coarse textured soil.

CCME. 2009. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Selenium.

CCME. 2015. Scientific Criteria Document for Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Nickel.

CCME. 2017. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - Methanol.

CCME. 2018. Scientific Criteria Document for the Development of the Canadian Soil Quality Guidelines for Zinc - Protection of Environmental and Human Health.

Efroymson et al. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision.

MOECC (Ontario Ministry of the Environment and Climate Change). 2016. Modified Generic Risk Assessment "Approved Model". Soil Components for Table 2 - Full Depth, Potable Water Scenario, Agricultural Land Use, coarse grained soil.

US EPA. 2024. Interim Ecological Soil Screening Level Documents.

Table 3.8: Toxicity Reference Values for Mammals and Birds
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Toxicity Reference Value (mg/kg-d)[(a)]				Notes
	Mammals		Birds		
	NOAEL	LOAEL	NOAEL	LOAEL	
Trichloroethylene	0.7	7	NA	NA	Sample et al. 1996
PHC F2 (C10-C16)	na	44.73	125	NA	Mammal: Stober 1962 as cited by FCSAP 2021 Bird: TRV for total PHCs; Szaro 1977 as cited by FCSAP 2021
Methanol	50	250	NA	NA	Sample et al. 1996
Cyanide	68.7	NA	NA	0.21	Mammal: Sample et al. 1996 Bird: Weimeyer et al. 1986 as cited in CCME, 1996
Antimony	98.0	112.9	9.8	11.3	Bird TRVs calculated by multiplying the mammal TRV with a safety factor of 0.1. NOAEL from Dieter et al. (1991) as quoted in Lynch et al. (1999). LOAEL from Rossi et al. (1987)
Arsenic	0.126	1.26	2.5	7.4	Sample et al. 1996
Barium	5.1	19.8	21	42	Sample et al. 1996
Beryllium	0.66	NA	0.066	NA	Sample et al. 1996; bird TRVs calculated by multiplying the mammal TRVs with safety a safety factor of 0.1
Cadmium	1	10	1.5	20	Sample et al. 1996
Chromium	3.3	13.1	1	5	Sample et al. 1996; mammals TRV based on chromium VI; bird TRV based on chromium III
Cobalt	0.2	2	2.37	4.74	Chetty et al. (1979) for mammal NOAEL TRV, Szakmary et al. (2001) for mammal LOAEL TRV, Van Vleet (1982 for bird TRVS
Copper	11.7	15.1	47	62	Sample et al. 1996
Lead	8	80	1.1	11.3	Sample et al. 1996
Manganese	88	284	977	NA	Sample et al. 1996
Mercury (inorganic)	1	NA	0.45	0.9	Sample et al. 1996
Methylmercury	0.015	0.025	0.0064	0.064	Sample et al. 1996
Molybdenum	0.26	2.6	3.5	35.3	Sample et al. 1996
Nickel	40	80	77.4	107	Sample et al. 1996
Selenium	0.2	0.3	0.4	0.8	Sample et al. 1996
Strontium	263	NA	26.3	NA	Sample et al. 1996; bird TRVs calculated by multiplying the mammal TRVs with safety a safety factor of 0.1
Thallium	0.0074	0.074	0.202	0.757	Sample et al. 1996; Ueberschar et al (1986)
Tin	23.4	35	6.8	16.9	Sample et al. 1996
Uranium	3.1	6.1	16	NA	Sample et al. 1996
Vanadium	0.2	2.1	11.4	NA	Sample et al. 1996
Zinc	160	320	14.5	131	Sample et al. 1996

Notes:
(a) TRVs for metals are from the Wildlife and HHRA Country Foods Screening Level Risk Assessment Plan Version 9 (Agnico Eagle 2024).
POPC = parameter of potential concern; mg/kg-d = milligrams per kilogram per day; EC20 = 20% effect concentration; LOAEL = lowest observed adverse effect level; LOEL = lowest observed effect level; NOAEL = no observed adverse effect level; NOEL = no observed effect level; TRV = toxicity reference value; NV = no value available; NA = not

References:
FCSAP (Federal Contaminated Site Action Plan). 2021. Ecological Risk Assessment Guidance. Module 7: Default Wildlife Toxicity Reference Values (TRVs) Recommended for use at FCSAP Sites. Version 1.0, April 2021.

Table 3.9: Soil Quality Remediation Objectives Calculations for Mammals and Birds - Northern Red-Backed Vole
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Soil SQRO - Vole (mg/kg dw)	Mammal TRVs (mg/kg d)		Food Concentrations (mg/kg ww)				Northern Red-Backed Vole		
		NOAEL	LOAEL	Berries	Lichens	Sedges	Insects	Dose (mg/kg d)	HQ NOAEL	HQ LOAEL
Trichloroethylene	80	7.0E-01	7.0E+00	1.9E+01	0.0E+00	6.5E+01	1.5E+02	7.00E+00	10.0	1.0
PHC F2 (C10-C16)	37275	na	4.5E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.47E+01	NC	1.0
Methanol	647	5.0E+01	2.5E+02	8.1E+02	0.0E+00	2.8E+03	0.0E+00	2.50E+02	5.0	1.0
Cyanide	177	6.9E+01	NA	2.2E+02	0.0E+00	7.6E+02	3.2E+01	6.87E+01	1.0	NC
Antimony	46175	9.8E+01	1.1E+02	1.4E+02	0.0E+00	7.8E-06	7.4E+03	1.13E+02	1.2	1.0
Arsenic	971	1.3E-01	1.3E+00	4.0E-02	0.0E+00	5.0E-01	8.3E+00	1.26E+00	10.0	1.0
Barium	14002	5.1E+00	2.0E+01	6.3E-01	0.0E+00	2.1E+01	2.0E+02	1.98E+01	3.9	1.0
Beryllium	268	6.6E-01	NA	6.0E+00	0.0E+00	7.4E-03	1.9E+00	6.60E-01	1.0	NC
Cadmium	7992	1.0E+00	1.0E+01	3.8E-04	0.0E+00	4.5E-01	5.6E+01	1.00E+01	10.0	1.0
Chromium	6923	3.3E+00	1.3E+01	3.7E+01	0.0E+00	6.9E+00	3.4E+02	1.31E+01	4.0	1.0
Cobalt	1363	2.0E-01	2.0E+00	2.9E+00	0.0E+00	4.1E-01	2.7E+01	2.00E+00	10.0	1.0
Copper	12230	1.2E+01	1.5E+01	5.4E-01	0.0E+00	3.3E+00	2.0E+01	1.51E+01	1.3	1.0
Lead	24103	8.0E+00	8.0E+01	2.7E+01	0.0E+00	6.7E+02	3.7E+01	8.00E+01	10.0	1.0
Manganese	230222	8.8E+01	2.8E+02	5.0E+00	0.0E+00	7.1E+01	3.2E+02	2.84E+02	3.2	1.0
Mercury (inorganic)	76	1.0E+00	NA	1.7E+01	0.0E+00	4.1E-03	1.4E-01	1.00E+00	1.0	NC
Methylmercury	2	1.5E-02	2.5E-02	2.1E-02	0.0E+00	1.1E-01	2.1E+00	2.50E-02	1.7	1.0
Molybdenum	45.6	2.6E-01	2.6E+00	8.2E-01	0.0E+00	3.3E+01	6.9E+00	2.60E+00	10.0	1.0
Nickel	64665	4.0E+01	8.0E+01	2.1E+00	0.0E+00	1.2E+01	2.1E+02	8.00E+01	2.0	1.0
Selenium	22.5	2.0E-01	3.0E-01	2.4E+00	0.0E+00	1.8E+00	1.5E+00	3.00E-01	1.5	1.0
Strontium	199876	2.6E+02	NA	2.2E+00	0.0E+00	5.7E+01	2.8E+03	2.63E+02	1.0	NC
Thallium	31	7.4E-03	7.4E-02	5.5E-01	0.0E+00	1.9E-03	1.1E+00	7.40E-02	10.0	1.0
Tin	9565	2.3E+01	3.5E+01	4.3E+01	0.0E+00	1.5E+02	1.5E+03	3.50E+01	1.5	1.0
Uranium	4810	3.1E+00	6.1E+00	2.9E+00	0.0E+00	9.1E-03	2.5E+01	6.10E+00	2.0	1.0
Vanadium	632	2.0E-01	2.1E+00	4.5E-02	0.0E+00	1.8E+01	4.2E+00	2.10E+00	10.5	1.0
Zinc	264744	1.6E+02	3.2E+02	4.2E-01	0.0E+00	1.3E+01	2.0E+02	3.20E+02	2.0	1.0

Notes:

Dose = TIA*[(SIR*Csoil/BW)+(FIR*Cb*Pb/BW)+(FIR*Cl*Pl/BW)+(FIR*Cs*Ps/BW)+(FIR*Ci*Pi/BW)]

Where:

Dose = dose (mg/kg bw/d)
BW = Body weight (kg)
Csoil = Concentration in soil (mg/kg)
Cb = Concentration in berries (mg/kg wet)
Cl = Concentration in lichens (mg/kg wet)
Cs = Concentration in sedges (mg/kg wet)
Ci = Concentration in insects (mg/kg wet)

FIR = Food ingestion rate (kg wet/d)
SIR = Soil ingestion rate (kg dw/d)
Pb = proportion in diet - berries
Pl = proportion in diet - lichens
Ps = proportion in diet - sedges
Pi = proportion in diet - insects
TIA = Time in Area

POPC = parameter of potential concern
TRV = Toxicity reference value (mg/kg d)
HQ = Hazard quotient = Dose/TRV
SQRO =Exposure point concentration (mg/kg dw)
NV =- No value
-- Not available
NC = Not calculated due to insufficient toxicity data

Table 3.10: Soil Quality Remediation Objectives Calculations for Mammals and Birds - Caribou
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Soil SQRO - Caribou (mg/kg dw)	Mammal TRVs (mg/kg d)		Food Concentrations (mg/kg ww)				Caribou		
		NOAEL	LOAEL	Berries	Lichens	Sedges	Insects	Dose (mg/kg d)	HQ NOAEL	HQ LOAEL
Trichloroethylene	1310	7.0E-01	7.0E+00	3.1E+02	1.6E+03	1.1E+03	0.0E+00	7.00E+00	10.0	1.0
PHC F2 (C10-C16)	286731	na	4.5E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.47E+01	NC	1.0
Methanol	9093	5.0E+01	2.5E+02	1.1E+04	5.8E+04	3.9E+04	0.0E+00	2.50E+02	5.0	1.0
Cyanide	2499	6.9E+01	NA	3.1E+03	1.6E+04	1.1E+04	0.0E+00	6.87E+01	1.0	NC
Antimony	262077	9.8E+01	1.1E+02	7.2E+02	2.2E+04	3.2E-06	0.0E+00	1.13E+02	1.2	1.0
Arsenic	8027	1.3E-01	1.3E+00	5.7E-02	2.1E+00	5.9E-01	0.0E+00	1.26E+00	10.0	1.0
Barium	126456	5.1E+00	2.0E+01	5.3E-01	1.1E+01	2.5E+01	0.0E+00	1.98E+01	3.9	1.0
Beryllium	4084	6.6E-01	NA	9.1E+01	2.3E-03	6.5E-03	0.0E+00	6.60E-01	1.0	NC
Cadmium	64084	1.0E+00	1.0E+01	2.4E-04	5.3E-01	7.9E-01	0.0E+00	1.00E+01	10.0	1.0
Chromium	80244	3.3E+00	1.3E+01	4.3E+02	1.4E+02	8.8E+00	0.0E+00	1.31E+01	4.0	1.0
Cobalt	12749	2.0E-01	2.0E+00	2.7E+01	1.1E+00	4.9E-01	0.0E+00	2.00E+00	10.0	1.0
Copper	96560	1.2E+01	1.5E+01	5.0E-01	9.3E+00	4.1E+00	0.0E+00	1.51E+01	1.3	1.0
Lead	404802	8.0E+00	8.0E+01	4.5E+02	9.9E+00	1.1E+04	0.0E+00	8.00E+01	10.0	1.0
Manganese	1819626	8.8E+01	2.8E+02	4.2E+00	1.7E+01	5.6E+01	0.0E+00	2.84E+02	3.2	1.0
Mercury (inorganic)	4727	1.0E+00	NA	1.1E+03	2.6E-01	3.0E-03	0.0E+00	1.00E+00	1.0	NC
Methylmercury	42	1.5E-02	2.5E-02	2.1E-02	4.4E+00	2.9E+00	0.0E+00	2.50E-02	1.7	1.0
Molybdenum	1051.0	2.6E-01	2.6E+00	1.9E+01	4.0E+02	7.6E+02	0.0E+00	2.60E+00	10.0	1.0
Nickel	511591	4.0E+01	8.0E+01	3.5E+00	5.1E+01	1.7E+01	0.0E+00	8.00E+01	2.0	1.0
Selenium	228.5	2.0E-01	3.0E-01	3.1E+01	7.1E+01	1.8E+01	0.0E+00	3.00E-01	1.5	1.0
Strontium	1671040	2.6E+02	NA	3.3E+00	6.7E+02	9.4E+01	0.0E+00	2.63E+02	1.0	NC
Thallium	461	7.4E-03	7.4E-02	8.2E+00	1.6E-02	1.5E-03	0.0E+00	7.40E-02	10.0	1.0
Tin	137864	2.3E+01	3.5E+01	6.2E+02	3.1E+03	2.1E+03	0.0E+00	3.50E+01	1.5	1.0
Uranium	16545	3.1E+00	6.1E+00	9.9E+00	1.1E+03	7.6E-03	0.0E+00	6.10E+00	2.0	1.0
Vanadium	3090	2.0E-01	2.1E+00	4.8E-02	4.6E+02	8.6E+01	0.0E+00	2.10E+00	10.5	1.0
Zinc	2051106	1.6E+02	3.2E+02	3.3E-01	2.8E+00	1.2E+01	0.0E+00	3.20E+02	2.0	1.0

Notes:

Dose = TIA*[(SIR*Csoil/BW)+(FIR*Cb*Pb/BW)+(FIR*Cl*Pl/BW)+(FIR*Cs*Ps/BW)+(FIR*Ci*Pi/BW)]

Where:

Dose = dose (mg/kg bw/d)
BW = Body weight (kg)
Csoil = Concentration in soil (mg/kg)
Cb = Concentration in berries (mg/kg wet)
Cl = Concentration in lichens (mg/kg wet)
Cs = Concentration in sedges (mg/kg wet)
Ci = Concentration in insects (mg/kg wet)

FIR = Food ingestion rate (kg wet/d)
SIR = Soil ingestion rate (kg dw/d)
Pb = proportion in diet - berries
Pl = proportion in diet - lichens
Ps = proportion in diet - sedges
Pi = proportion in diet - insects
TIA = Time in Area

POPC = parameter of potential concern
TRV = Toxicity reference value (mg/kg d)
HQ = Hazard quotient = Dose/TRV
SQRO =Exposure point concentration (mg/kg dw)
NV =- No value
-- Not available
NC = Not calculated due to insufficient toxicity data

Table 3.11: Soil Quality Remediation Objectives Calculations for Mammals and Birds - Lapland Longspur
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Soil SQRO - Longspur (mg/kg dw)	Bird TRVs (mg/kg d)		Food Concentrations (mg/kg ww)				Lapland Longspur		
		NOAEL	LOAEL	Berries	Lichens	Sedges	Insects	Dose (mg/kg d)	HQ NOAEL	HQ LOAEL
Trichloroethylene	14	NA	NA	3.3E+00	0.0E+00	1.1E+01	2.6E+01	7.00E+00	NC	NC
PHC F2 (C10-C16)	21769	1.3E+02	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.25E+02	1.0	NC
Methanol	660	NA	NA	8.3E+02	0.0E+00	2.8E+03	0.0E+00	2.50E+02	NC	NC
Cyanide	0.50	NA	2.1E-01	6.3E-01	0.0E+00	2.1E+00	9.0E-02	2.10E-01	NC	1.0
Antimony	264	9.8E+00	1.1E+01	1.1E+00	0.0E+00	1.1E-04	4.2E+01	1.13E+01	1.2	1.0
Arsenic	954	2.5E+00	7.4E+00	4.0E-02	0.0E+00	4.9E-01	8.1E+00	7.40E+00	3.0	1.0
Barium	4431	2.1E+01	4.2E+01	6.8E-01	0.0E+00	2.0E+01	6.5E+01	4.20E+01	2.0	1.0
Beryllium	8	6.6E-02	NA	1.9E-01	0.0E+00	8.6E-03	6.0E-02	6.60E-02	1.0	NC
Cadmium	2403	1.5E+00	2.0E+01	4.9E-04	0.0E+00	3.3E-01	2.7E+01	2.00E+01	13.3	1.0
Chromium	267	1.0E+00	5.0E+00	1.4E+00	0.0E+00	5.1E+00	1.3E+01	5.00E+00	5.0	1.0
Cobalt	458	2.4E+00	4.7E+00	9.6E-01	0.0E+00	3.7E-01	8.9E+00	4.74E+00	2.0	1.0
Copper	9979	4.7E+01	6.2E+01	5.4E-01	0.0E+00	3.3E+00	1.9E+01	6.20E+01	1.3	1.0
Lead	1272	1.1E+00	1.1E+01	1.4E+00	0.0E+00	3.5E+01	4.7E+00	1.13E+01	10.3	1.0
Manganese	158959	9.8E+02	NA	5.1E+00	0.0E+00	7.4E+01	2.5E+02	9.77E+02	1.0	NC
Mercury (inorganic)	92	4.5E-01	9.0E-01	2.0E+01	0.0E+00	4.1E-03	1.4E-01	9.00E-01	2.0	1.0
Methylmercury	0.20	6.4E-03	6.4E-02	9.2E-03	0.0E+00	1.4E-02	2.7E-01	6.40E-02	10.0	1.0
Molybdenum	349.1	3.5E+00	3.5E+01	6.2E+00	0.0E+00	2.5E+02	5.3E+01	3.53E+01	10.1	1.0
Nickel	16385	7.7E+01	1.1E+02	1.5E+00	0.0E+00	9.4E+00	5.2E+01	1.07E+02	1.4	1.0
Selenium	28.4	4.0E-01	8.0E-01	3.1E+00	0.0E+00	2.3E+00	1.7E+00	8.00E-01	2.0	1.0
Strontium	2740	2.6E+01	NA	9.9E-01	0.0E+00	2.1E+01	3.8E+01	2.63E+01	1.0	NC
Thallium	53	2.0E-01	7.6E-01	9.5E-01	0.0E+00	1.8E-03	1.9E+00	7.57E-01	3.7	1.0
Tin	384	6.8E+00	1.7E+01	1.7E+00	0.0E+00	5.9E+00	6.1E+01	1.69E+01	2.5	1.0
Uranium	2295	1.6E+01	NA	1.4E+00	0.0E+00	1.0E-02	1.2E+01	1.60E+01	1.0	NC
Vanadium	1188	1.1E+01	NA	4.6E-02	0.0E+00	3.3E+01	8.0E+00	1.14E+01	1.0	NC
Zinc	18182	1.5E+01	1.3E+02	5.9E-01	0.0E+00	1.3E+01	1.1E+02	1.31E+02	9.0	1.0

Notes:

Dose = TIA*[(SIR*Csoil/BW)+(FIR*Cb*Pb/BW)+(FIR*Cl*Pl/BW)+(FIR*Cs*Ps/BW)+(FIR*Ci*Pi/BW)]

Where:

Dose = dose (mg/kg bw/d)
BW = Body weight (kg)
Csoil = Concentration in soil (mg/kg)
Cb = Concentration in berries (mg/kg wet)
Cl = Concentration in lichens (mg/kg wet)
Cs = Concentration in sedges (mg/kg wet)
Ci = Concentration in insects (mg/kg wet)

FIR = Food ingestion rate (kg wet/d)
SIR = Soil ingestion rate (kg dw/d)
Pb = proportion in diet - berries
Pl = proportion in diet - lichens
Ps = proportion in diet - sedges
Pi = proportion in diet - insects
TIA = Time in Area

POPC = parameter of potential concern
TRV = Toxicity reference value (mg/kg d)
HQ = Hazard quotient = Dose/TRV
SQRO =Exposure point concentration (mg/kg dw)
NV =- No value
-- Not available
NC = Not calculated due to insufficient toxicity data

Table 3.12: Soil Quality Remediation Objectives Calculations for Mammals and Birds - Canada Goose
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Soil SQRO - Goose (mg/kg dw)	Bird TRVs (mg/kg d)		Food Concentrations (mg/kg ww)				Canada Goose		
		NOAEL	LOAEL	Berries	Lichens	Sedges	Insects	Dose (mg/kg d)	HQ NOAEL	HQ LOAEL
Trichloroethylene	76796	NA	NA	1.8E+04	0.0E+00	6.2E+04	0.0E+00	4.32E+02	NC	NC
PHC F2 (C10-C16)	1386364	1.3E+02	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.25E+02	1.0	NC
Methanol	2559124	NA	NA	3.2E+06	0.0E+00	1.1E+07	0.0E+00	7.50E+04	NC	NC
Cyanide	7.2	NA	2.1E-01	9.0E+00	0.0E+00	3.1E+01	0.0E+00	2.10E-01	NC	1.0
Antimony	107226	9.8E+00	1.1E+01	3.1E+02	0.0E+00	5.1E-06	0.0E+00	1.13E+01	1.2	1.0
Arsenic	82049	2.5E+00	7.4E+00	8.4E-02	0.0E+00	7.1E-01	0.0E+00	7.40E+00	3.0	1.0
Barium	464215	2.1E+01	4.2E+01	4.8E-01	0.0E+00	2.7E+01	0.0E+00	4.20E+01	2.0	1.0
Beryllium	316	6.6E-02	NA	7.1E+00	0.0E+00	7.3E-03	0.0E+00	6.60E-02	1.0	NC
Cadmium	221753	1.5E+00	2.0E+01	1.9E-04	0.0E+00	1.1E+00	0.0E+00	2.00E+01	13.3	1.0
Chromium	41973	1.0E+00	5.0E+00	2.2E+02	0.0E+00	8.3E+00	0.0E+00	5.00E+00	5.0	1.0
Cobalt	46785	2.4E+00	4.7E+00	9.8E+01	0.0E+00	5.5E-01	0.0E+00	4.74E+00	2.0	1.0
Copper	687308	4.7E+01	6.2E+01	4.6E-01	0.0E+00	5.0E+00	0.0E+00	6.20E+01	1.3	1.0
Lead	46752	1.1E+00	1.1E+01	5.1E+01	0.0E+00	1.3E+03	0.0E+00	1.13E+01	10.3	1.0
Manganese	10832950	9.8E+02	NA	3.6E+00	0.0E+00	4.6E+01	0.0E+00	9.77E+02	1.0	NC
Mercury (inorganic)	712	4.5E-01	9.0E-01	1.6E+02	0.0E+00	3.5E-03	0.0E+00	9.00E-01	2.0	1.0
Methylmercury	139	6.4E-03	6.4E-02	9.2E-03	0.0E+00	9.7E+00	0.0E+00	6.40E-02	10.0	1.0
Molybdenum	8792.5	3.5E+00	3.5E+01	1.6E+02	0.0E+00	6.4E+03	0.0E+00	3.53E+01	10.1	1.0
Nickel	1185313	7.7E+01	1.1E+02	4.3E+00	0.0E+00	2.0E+01	0.0E+00	1.07E+02	1.4	1.0
Selenium	615.3	4.0E-01	8.0E-01	9.1E+01	0.0E+00	5.0E+01	0.0E+00	8.00E-01	2.0	1.0
Strontium	287908	2.6E+01	NA	2.4E+00	0.0E+00	6.2E+01	0.0E+00	2.63E+01	1.0	NC
Thallium	4123	2.0E-01	7.6E-01	7.3E+01	0.0E+00	1.3E-03	0.0E+00	7.57E-01	3.7	1.0
Tin	86797	6.8E+00	1.7E+01	3.9E+02	0.0E+00	1.3E+03	0.0E+00	1.69E+01	2.5	1.0
Uranium	171431	1.6E+01	NA	1.0E+02	0.0E+00	5.4E-03	0.0E+00	1.60E+01	1.0	NC
Vanadium	48004	1.1E+01	NA	5.4E-02	0.0E+00	1.3E+03	0.0E+00	1.14E+01	1.0	NC
Zinc	1452167	1.5E+01	1.3E+02	3.5E-01	0.0E+00	1.2E+01	0.0E+00	1.31E+02	9.0	1.0

Notes:

Dose = TIA*[(SIR*Csoil/BW)+(FIR*Cb*Pb/BW)+(FIR*Cl*Pl/BW)+(FIR*Cs*Ps/BW)+(FIR*Ci*Pi/BW)]

Where:

Dose = dose (mg/kg bw/d)
BW = Body weight (kg)
Csoil = Concentration in soil (mg/kg)
Cb = Concentration in berries (mg/kg wet)
Cl = Concentration in lichens (mg/kg wet)
Cs = Concentration in sedges (mg/kg wet)
Ci = Concentration in insects (mg/kg wet)

FIR = Food ingestion rate (kg wet/d)
SIR = Soil ingestion rate (kg dw/d)
Pb = proportion in diet - berries
Pl = proportion in diet - lichens
Ps = proportion in diet - sedges
Pi = proportion in diet - insects
TIA = Time in Area

POPC = parameter of potential concern
TRV = Toxicity reference value (mg/kg d)
HQ = Hazard quotient = Dose/TRV
SQRO =Exposure point concentration (mg/kg dw)
NV =- No value
-- Not available
NC = Not calculated due to insufficient toxicity data

Table 4.1: Summary of Soil Quality Remediation Objectives (SQROs)
Meadowbank Complex Soil Quality Remediation Objectives

POPC	Human Health SQRO[(a)]	Ecological Health SQRO[(b)]	Maximum Background [(c)]	Generic Soil Quality Guidelines[(d)]		Site SQRO[(h)]	SQRO Driving Pathway
Trichloroethylene	48	**3**	-	0.01	(e)	3	Eco - soil contact
PHC F2 (C10-C16)	50,122	**150**	-	**150**	(f)	150	Eco - soil contact
Methanol	820	**647**	-	4.6	(e)	647	Eco - vole
Cyanide	0.82	0.50	-	**0.9**	(e)	0.90	Eco - soil contact (generic)
Antimony	44	5	<10	**20**	(e)	20	CCME 1991 interim SQG
Arsenic	199	17	**173**	12	(e)	173	Maximum background
Barium	19,458	330	174	**500**	(e)	500	CCME 1999 SQG
Beryllium	46	**8.4**	1.13	4	(e)	8.4	Eco - longspur
Cadmium	7.1	**10**	0.62	**10**	(e)	10	Eco - soil contact
Chromium	214	64	**193**	64	(e)	193	Maximum background
Cobalt	118	13	16.4	**50**	(e)	50	CCME 1991 interim SQG
Copper	2,153	**63**	26.1	**63**	(e)	63	Eco - soil contact
Lead	2,711	**300**	55	140	(e)	300	Eco - soil contact
Manganese	2.0	220	**721**	NV	(g)	721	Maximum background
Mercury (inorganic)	0.70	12	0.36	**6.6**	(e)	6.6	HH - soil ingestion (generic)
Methylmercury	76	0.20				6.6	HH - soil ingestion (generic)
Molybdenum	114	2	0.51	**10**	(e)	10	CCME 1991 interim SQG
Nickel	4,802	45	**97.3**	45	(e)	97.3	Maximum background
Selenium	27	**1**	0.1	**1**	(e)	1	Eco - soil contact
Strontium	44,488	**2,740**	42.6	NV	(g)	2,740	Eco - longspur
Thallium	0.39	1.4	<1.0	**1**	(e)	1	CCME provisional SQG_{HH}
Tin	13,997	**50**	<5	**50**	(e)	50	Eco - soil contact
Uranium	**229**	500	3.08	23	(e)	229	HH - direct soil contact
Vanadium	793	**130**	32.5	**130**	(e)	130	Eco - soil contact
Zinc	7,168	**250**	64.5	**250**	(e)	250	Eco - soil contact

Notes:

Bold and Shaded Selected value for Site SQRO

All units in milligrams per kilogram dry weight (mg/kg dw).

(a) Derived based on human health exposure pathways: soil direct contact (ingestion, dermal, inhalation), consumption of berries, consumption of caribou (meat and organs), and consumption of goose (meat).

(b) Derived based on ecological exposure pathways: soil direct contact by plants and soil invertebrates, incidental ingestion of soil and ingestion of food items by mammals and birds (caribou, Canada goose, Lapland longspur and northern red-backed vole).

(c) Represents the maximum measured concentration of baseline data for Meadowbank and Whale Tail mines (Section 4.1 of the Closure and Reclamation Plan Human Health and Ecological Risk Assessment).

(d) Generic Soil Quality Guidelines were selected as the Canadian Council of Ministers of the Environment (CCME) Soil Quality Guidelines (SQGs) or Canada-Wide Standards (CWSs). In the absence of a CCME value, the lower of the United States Environmental Protection Agency (US EPA) Regional Screening Levels (RSLs) (human health) or

(e) CCME Canadian Soil Quality Guidelines for the Protection of Environment and Human Health (CCME 1999b, and updates) for residential land use, coarse soil.

(f) CCME (2008). Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale. Supporting Technical Document. January 2008.

(g) No CCME soil quality guideline exists for this COPC.

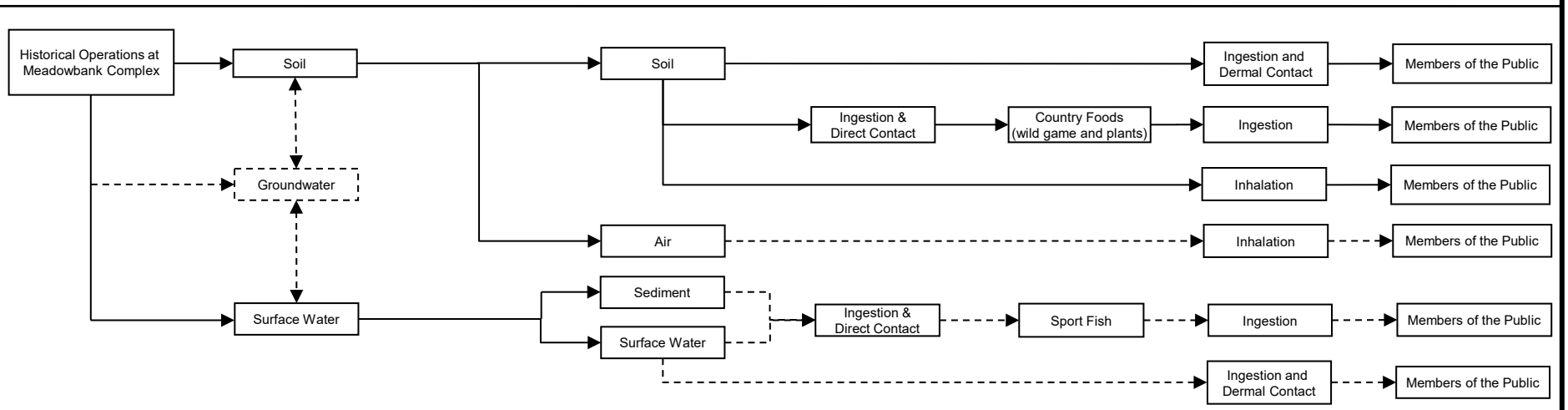
(h) Site SQROs were selected as the lower of the Human Health and Ecological Health SQROs, unless the value was less than background or less than the generic soil quality guidelines.

POPC = parameter of potential concern; SQRO = soil quality remediation objective.

Figures

Conceptual Site Model for the Meadowbank Complex Soil Quality Remediation Objectives – Human Health

FIGURE 1-1



NOTES

Solid lines indicate pathways that were considered to be complete and considered in the development of the Soil Quality Remediation Objectives.

Dashed lines indicate pathways that were considered to be incomplete (i.e., medium not impacted during post-closure) or not considered in the development of the Soil Quality Remediation Objectives.

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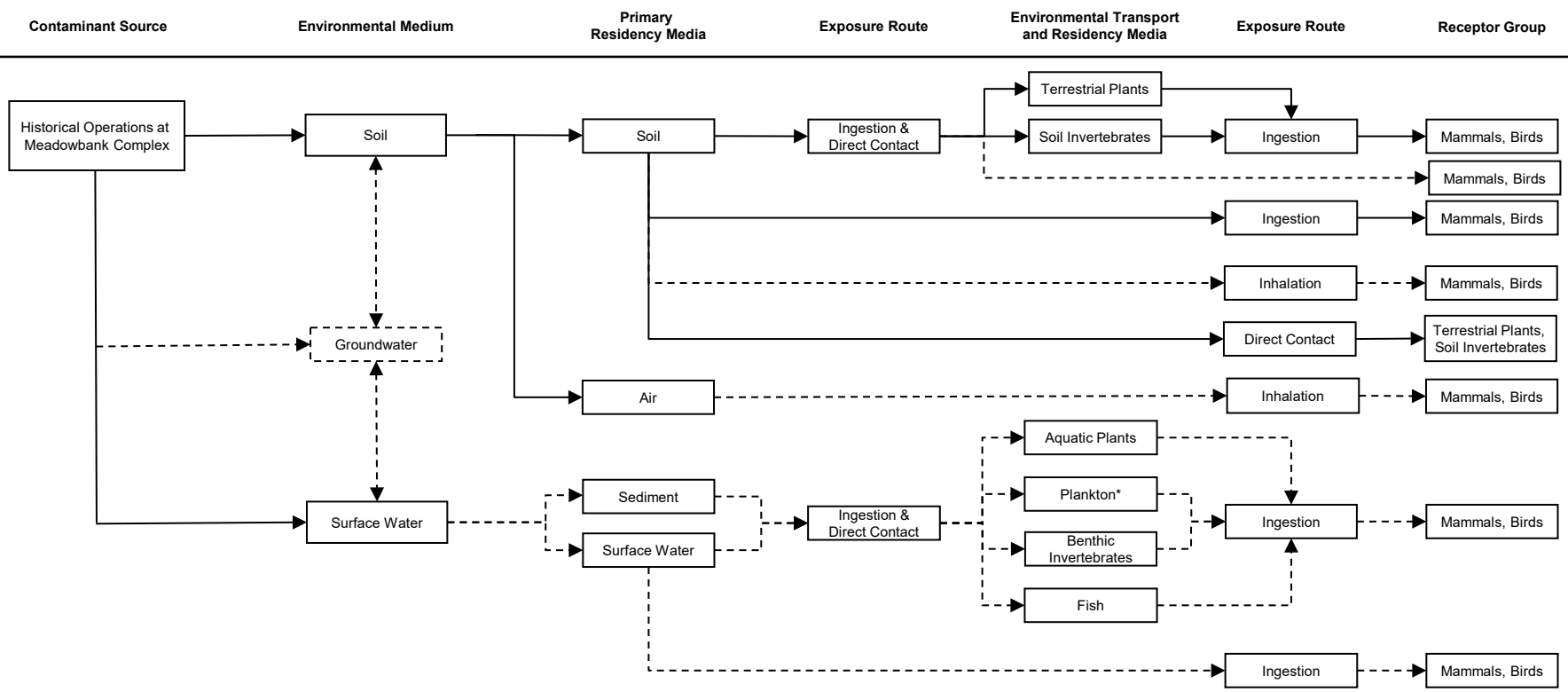
Conceptual Site Model for the Meadowbank Complex Soil Quality Remediation Objectives – Terrestrial Health

FIGURE 1-2



NOTES

* Phytoplankton and zooplankton

Solid lines indicate pathways that were considered to be complete and considered in the development of the Soil Quality Remediation Objectives.

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