Appendix 40

Wildlife and HHRA Country Foods Screening Level Risk Assessment Plan Version 9

MEADOWBANK COMPLEX

Wildlife and HHRA Country Foods Screening Level Risk Assessment Plan

In Accordance with NIRB Project Certificate No.004

Version 9

March, 2024

IMPLEMENTATION SCHEDULE

This Plan will be implemented immediately subject to any modifications proposed by the NIRB as a result of the review and approval process.

DISTRIBUTION LIST

Agnico Eagle – Environment and Critical Infrastructures Superintendent

Agnico Eagle – Environment General Supervisor

Agnico Eagle – Environmental Coordinator

Agnico Eagle – Environmental Technician

DOCUMENT CONTROL

Version	Date (YMD)	Section	Revision
1	2016-03-31	All	Comprehensive plan for Meadowbank Project
2	2018-06-01	2.5	ROC based on a commitment made during the Whale Tail Final Hearing through discussions with Environment and Climate Change Canada
3	2019-04-25	Throughout 3.4	Version 2 text expanded to describe assessment of risks to Semi-Palmated Sandpiper from exposure to contaminants in the TSF. Updated time-in-area for caribou from 33% to 12% based on collaring data.
4	2021-04-12	2.4	Introduced screening of potential COPCs in soil and water samples using soil and water quality guidelines or baseline +10%, according to Golder, 2016/Agnico Eagle, 2019.
		3.2	Reduction of sampling effort from 5 samples per monitoring station to 3 samples
		3.4	Updated time-in-area factors according to Golder, 2019.
		Throughout	Added analysis of risk to all receptors of concern from consumption of tailings material.
5	2021-08-27	Appendix B	Updated SOP to reflect V4 sampling requirements (3 locations, additional tailings samples) and corrected sample site coordinates.
6	2022-04-11	Section 2.1	Conceptual model added.
		Section 2.1.3	Clarified pathway for shorebirds (TSF only). Previously this section erroneously suggested tundra pathways would also be assessed, which was not planned, as indicated in Section 3.4.
		Section 2.2	EDI approach updated to align with Golder (2019b) – adopted method of calculating EDI for assessment location only, rather than assessment location + external reference combined.
		Section 2.2.2	Kangislulik (Mammoth) Lake added as an assessment location for water quality, due to discharge of effluent in this location
		Section 2.2.2.2	Dietary preferences – percentage of benthic invertebrates obtained from the TSF adjusted to 13% from 100%, based on results of 2021 field study (further described in Section 3.3)
		Section 2.3	TRVs – removed allometric scaling factor for mammalian TRVs to align with Golder (2019a,b) methods, as recommended in Allard et al. (2010).

Version	Date (YMD)	Section	Revision
		Former Appendix A	Appendix A (example calculation) removed for brevity since the components are clearly presented in main text.
		Appendix A	Updated SOP with selected 2021 Whale Tail site UTM coordinates and tailings beach sediment sample collection (for consideration).
		Section 3 and throughout	$HHRA_{country foods}$ Assessment Plan added
7	2022-07-14	Section 2.2.1	Minor correction to soil intake values to properly reflect diet % moisture value indicated.
		Section 2.2.2.2	Proportion of shorebird diet obtained from TSF adjusted from 13% to 100% (more conservative) per ECCC recommendation.
8	2023-01-25	Section 2.2.2.1 & Appendix A	Methods for collection and analysis of tailings sediment samples updated (collection of beach sediment rather than mill effluent)
9	2024-03	Throughout	Text revisions for clarity.
		Section 2.2.2	Updated BSAFs to include more empirically-derived values from the available literature.
		Section 3	Updated Health Canada guidance document references (Health Canada, 2021a & b). No significant change to methods, except TDIs will be revised according to Health Canada, 2021b in subsequent analyses.
		Section 3.1.3	To identify COPCs, collected soil and water samples will be screened against maximum measured background concentrations, rather than background + 10%.

Prepared By: Meadowbank Environment Department

Approved by: Eric Haley

Environment and Critical Infrastructures Superintendent

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

In 2006, Azimuth Consulting Group Inc. conducted a pre-construction wildlife screening level risk assessment (WSLRA) for the Meadowbank Mine to assess potential future risks to wildlife via dietary uptake of mine-related contaminants (Azimuth, 2006). Specifically, the pre-construction SLRA focused on determining the contaminants of potential concern (COPCs) from planned minesite activities, and evaluating potential risks to wildlife from exposure to contaminants under baseline conditions as well as predicted conditions during mine operation.

Under baseline conditions, negligible risks were found for all COPCs except chromium, which was determined to pose an improbable but potential risk for songbirds due to naturally elevated concentrations in the region. COPC exposure concentrations were not expected to increase during mine operation, so potential risks were not expected to change from baseline conditions.

In addition, a pre-construction risk assessment for consumption of country foods ($HHRA_{country\ foods}$) was completed (Wilson Scientific, 2006) to assess risk to human receptors associated with ingestion of various country foods under baseline and future operational conditions. No incremental risks from consumption of country foods were predicted as a result of mine operations.

In 2016, Agnico Eagle submitted a Final Environmental Impact Statement (EIS) to NIRB for the Whale Tail Mine satellite deposit (Agnico Eagle, 2016) at the Meadowbank Complex. This FEIS included assessments of risk to wildlife and country foods consumers in the Whale Tail Mine area under baseline and future operational conditions. Concentrations of contaminants in soil were not predicted to change or the changes met screening criteria, so no residual impacts to soil and subsequently, vegetation and prey quality were predicted as a result of mine operation, and no quantitative risk characterization (hazard quotient calculation) was required. Results of an updated assessment conducted in support of the Whale Tail Mine Expansion Project in 2018 – 2019 (Golder, 2019a) presented the same conclusion. An additional assessment for exposure of wildlife receptors of concern to contaminants in ingested tailings water and sediment (Golder, 2019b) found that while screening values were exceeded for a number of parameters, risks were acceptable (HQ <1) for all receptors.

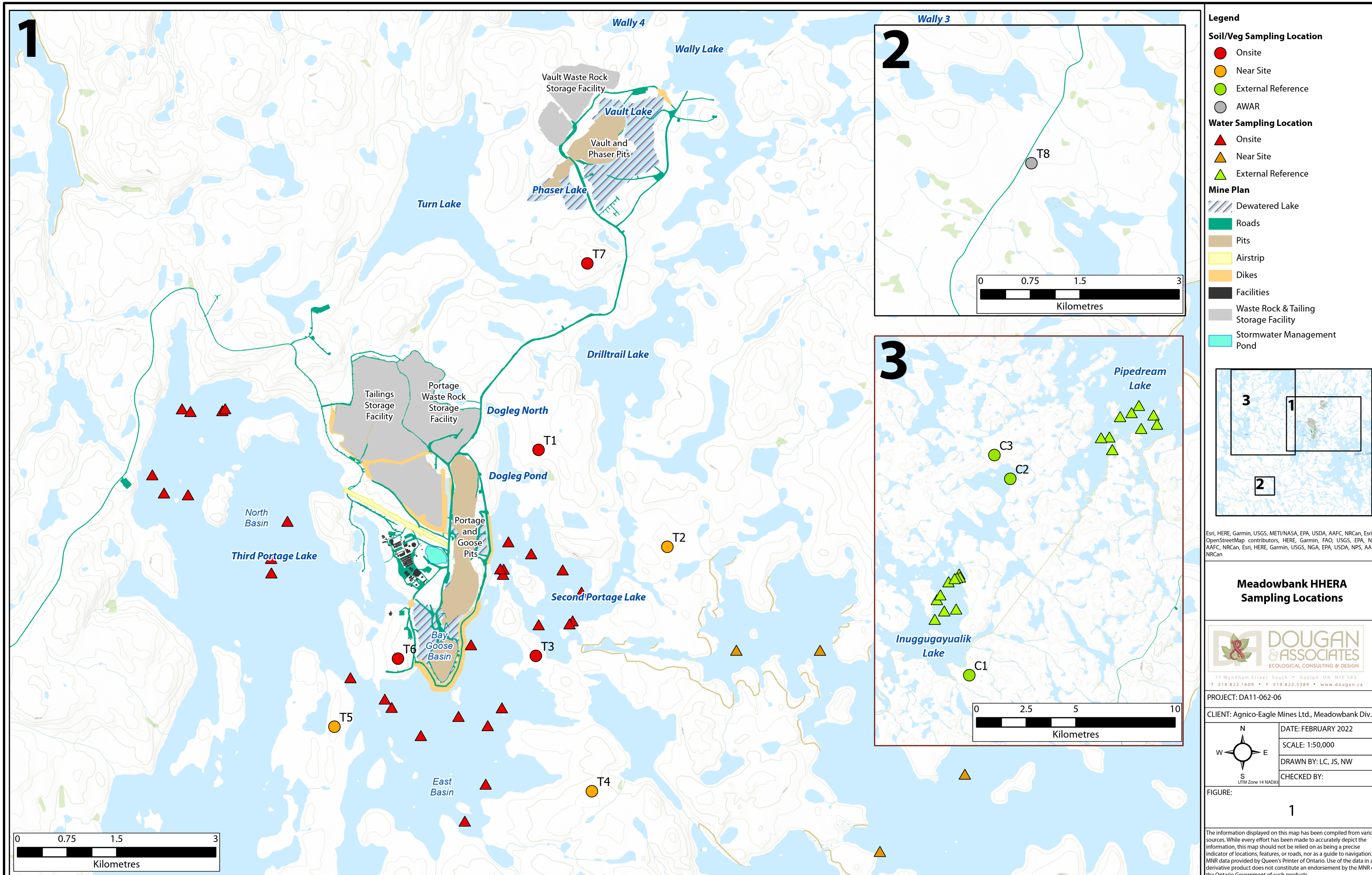
While no incremental risks to wildlife or country foods consumers were predicted in environmental assessments for the Meadowbank Complex, Agnico Eagle will continue to validate these predictions every three years, during operations, as required under Nunavut Impact Review Board Project Certificate No.004 - Condition 67.

This plan is intended to guide the WSLRA and $HHRA_{country\ foods}$ risk assessment process, and methods in each reporting year will be reviewed and adjusted as required, based on current practices and guidance available at the time.

1.2 GENERAL APPROACH

The goal of the Meadowbank Complex WSLRA and $HHRA_{country\ foods}$ is to validate FEIS-phase predictions of risk for wildlife and general public consumers of country foods from ingestion of chemical contaminants under operational conditions. The general approach includes the common risk assessment components of problem formulation, exposure assessment, toxicity assessment and risk characterization. In particular, assessments will aim to distinguish risk due to operation of the mine from risk due to background conditions by collecting samples of environmental media from a variety of potentially impacted and reference locations in each assessment year (Figures 1 and 2; further described in Section 2.2.2).

Risk assessments will follow a hazard quotient approach, and are based on food-chain modeling developed for the baseline screening level risk assessments at the Meadowbank Mine (Azimuth, 2006; Wilson Scientific, 2006) and updated using methods from the Whale Tail Mine assessments (Golder 2019a,b) as described below. The risk assessment framework has been developed according to various standard Canadian and American sources, with updates as available (e.g. CCME, 1996, 2020; USEPA, 1998; Health Canada, 2012, 2021a).


1
Wally 4
Wally Lake
Wally 3
Vault Waste Rock Storage Facility
Vault Lake
Vault and Phaser Pits
Phaser Lake
Turn Lake
T7
Drilltrail Lake
Tailings Storage Facility
Portage Waste Rock Storage Facility
Dogleg North
T1
Dogleg Pond
North Basin
Third Portage Lake
Portage and Goose Pits
T2
Second Portage Lake
Bay Goose Basin
T6
T3
T5
East Basin
T4
0 0.75 1.5 3
Kilometres
2
T8
0 0.75 1.5 3
Kilometres
3
Pipedream Lake
C3
C2
Inuggugayualik Lake
C1
0 2.5 5 10
Kilometres
Legend
Soil/Veg Sampling Location
Onsite
Near Site
External Reference
AWAR
Water Sampling Location
Onsite
Near Site
External Reference
Mine Plan
Dewatered Lake
Roads
Pits
Airstrip
Dikes
Facilities
Waste Rock & Tailing Storage Facility
Stormwater Management Pond
3
1
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Esri, HERE, Garmin, USGS, METI/NASA, EPA, USDA, AAFC, NRCan, Esri, © OpenStreetMap contributors, HERE, Garmin, FAO, USGS, EPA, NPS, AAFC, NRCan, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS, AAFC, NRCan
Meadowbank HHERA Sampling Locations
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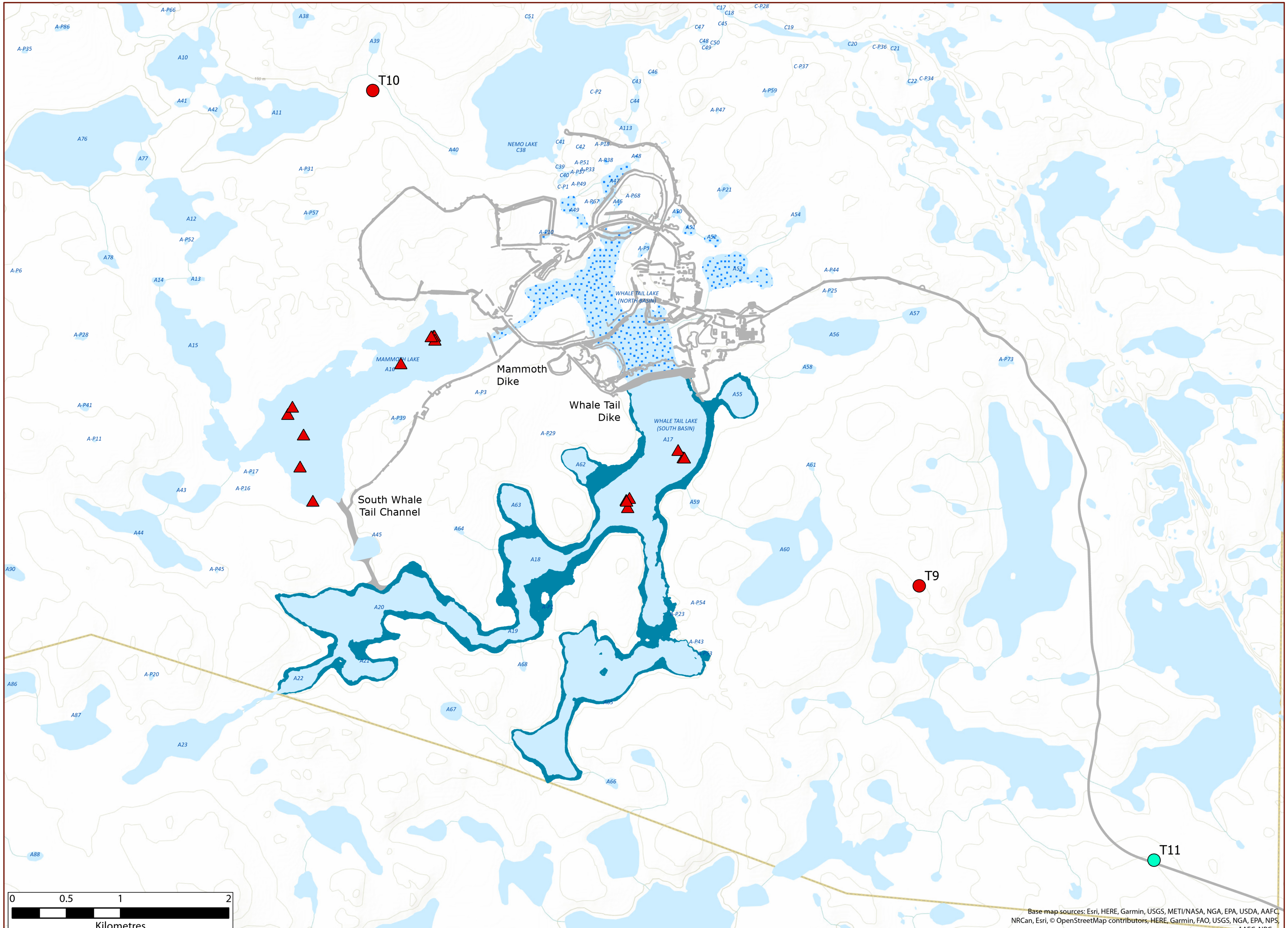
PROJECT: DA11-062-06
CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.
N
W
E
S
UTM Zone 14 NAD83
DATE: FEBRUARY 2022
SCALE: 1:50,000
DRAWN BY: LC, JS, NW
CHECKED BY:
FIGURE:
1
The information displayed on this map has been compiled from various sources. While every effort has been made to accurately depict the information, this map should not be relied on as being a precise indicator of locations, features, or roads, nor as a guide to navigation. MNR data provided by Queen's Printer of Ontario. Use of the data in any derivative product does not constitute an endorsement by the MNR or the Ontario Government of such products.



Legend

- Water Sampling Location
- Soil/Veg Sampling Location
- Soil/Veg Sampling Location - WTHR
- Dewatered Lake
- Infrastructure

South Whale Tail Lake Elevations

- Baseline Water Level
- Flood Zone

Whale Tail HHERA Sampling Locations

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PROJECT: DA11-062-06

CLIENT: Agnico-Eagle Mines Ltd., Meadowbank Div.

N W E S
UTM Zone 14 NAD83

DATE: JANUARY 2022

SCALE:

DRAWN BY: LC, JS, NW

CHECKED BY:

FIGURE:

2

1.3 LOCATION DESCRIPTION

The Meadowbank Mine is located 70 km north of the hamlet of Baker Lake, Nunavut, near the border of the Northern and Southern Arctic ecozones. The Whale Tail Mine is located a further 50 km north-west. Collectively these sites are referred to as the Meadowbank Complex. Terrain in the Meadowbank area is typical barren-ground subarctic, with low-growing vegetation in poorly developed soil with continuous permafrost. The landscape is dominated by many interconnected lakes and isolated ponds with indistinct drainage patterns. Topography consists of rolling hills, boulder fields and bedrock outcrops. The site is located at the headwaters of the Quioch River system, which flows southeast through Chesterfield Inlet into Hudson Bay. Lakes in this region are ultra-oligotrophic, with low productivity levels. This region supports few terrestrial mammals (15 species) and birds (62 species) (Azimuth, 2006). Migratory species (primarily caribou and Canada geese) are present.

1.4 SITE FACILITIES

The Meadowbank Complex consists of several gold-bearing deposits, primarily mined as open pits (Portage, Goose, Vault, Phaser, Whale Tail, and IVR Pits). The Whale Tail Mine also has underground operations. Much of the original Meadowbank Mine infrastructure is located in close proximity to the Meadowbank mill, with the exception of Vault and Phaser Pits which are approximately 10 km northeast of the main site. The Whale Tail Mine, which was permitted in 2018, is approximately 50 km northwest of the site. Operations at the Portage, Vault and Phaser Pits ceased in 2019, and simultaneously operations at the Whale Tail Mine began.

Waste rock from the pits is stored in the Portage Waste Rock Storage Facility, Vault Waste Rock Storage Facility, Whale Tail and IVR Waste Rock Storage Facilities (RSFs). Rock Storage Facilities are constructed to minimize the disturbed area and will be capped with a layer of non-potentially acid-generating rock (NPAG). During the construction period, NPAG is also used for construction of dikes and roads. Mined ore is either processed in the mill or stockpiled for eventual processing.

Tailings are stored in the Tailings Storage Facility (TSF), located at the Meadowbank Mine. The TSF is defined by the series of dikes built around and across the basin of the dewatered northwest arm of Second Portage Lake. In-pit disposal has also been occurring in Portage and Goose Pits since 2019. Tailings water is reclaimed for use in ore processing.

An onsite airstrip supports transportation of goods and personnel to and from the Meadowbank Complex by jet. A 110-km All Weather Access Road (AWAR) runs between the Meadowbank Mine and the hamlet of Baker Lake, where Agnico Eagle maintains a bulk fuel storage and barge facility. The Vault and Phaser Pits area is connected to the Meadowbank Mine by a 10-km haul road, and the Whale Tail Mine is connected to the Vault and Phaser Pits area by a 62-km haul road.

1.5 SOURCES OF CONTAMINANTS

Major mine site operations and their potential to contribute to COPCs (based on Azimuth, 2006 and Golder, 2019a) are summarized here.

Open pits – Along with ore, pits produce waste rock, which may contribute to COPCs through dust emissions.

Rock storage facilities – Waste rock (not containing ore) is moved to these areas. Dust may be blown from the rock piles during dumping and vehicle traffic during transport of material. Seepage from rock storage facilities is controlled in sumps and pumped back to attenuation ponds or the TSF.

Borrow pits and quarries – Borrow pits and quarries are used as necessary for the construction of mine site roads and road maintenance. The COPCs for borrow pits and quarries are similar to open pits.

Tailings Storage Facilities (TSF) – The northwest arm of Second Portage Lake was partitioned off by the East Dike and de-watered from 2009 to 2012. This area was further partitioned by the Central Dike and Stormwater Dike to create the North and South Cell TSF. This material is fine-grained and could be a source of dust emissions during dry periods, prior to capping. Tailings are also disposed in Portage and Goose Pits, but a sub-aqueous method is used so these tailings are not considered as a source of dust emissions.

Roads and airstrip – Frequently-used gravel haul roads run throughout the mine site to connect pits, waste rock storage and processing facilities. An airstrip, receiving approximately five planes per week, was built at the mine site to receive deliveries and personnel. Dust from these sources could be a potential source of contaminants. A 110 km long all-weather access road (AWAR) was constructed between the mine and the Hamlet of Baker Lake, using gravel from quarries along the road, and the Whale Tail Mine satellite deposit is connected by a 62-km haul road to the Meadowbank Mine.

Effluent discharge – Dewatering of lakes for mine construction is considered effluent discharge and is regulated under the current NWB Water License and MDMER. Lake water is treated for suspended solids before discharge, if needed, and since it is an existing surface water source, it is not likely to be a source of contaminants in the receiving water. Effluent is also periodically discharged from attenuation ponds into adjacent lakes, under NWB Water License and MDMER requirements. As a result, metals regulated under MDMER are evaluated for potential as COPCs.

Diesel generating plant, mine mill plant and associated facilities – Diesel generating plants provide power for the mine. The Air Quality Impact Assessment (2005) determined emission of PAHs was “very low” and did not require modeling. The milling of rock in the processing plant takes place under wet conditions, and is not a source of particulate emissions. Health and safety-related requirements to reduce particulate emissions during handling of the ore at the mine plant before processing are in place, so these are not expected to be a significant source of contaminants to the receiving environment.

Overall, roads, waste rock and tailings were determined to be the main sources potentially contributing to COPCs through dust emissions. Dewatering effluent discharge may potentially contribute to COPCs in water sources, along with physical changes to waterbodies for the Whale Tail Mine (flooding). In addition, risks to wildlife from exposure to contaminants within the tailings storage facility are now considered, following discussions with Environment and Climate Change Canada during the Final Hearing for the Whale Tail Pit project (2017).

2 WILDLIFE ASSESSMENT

2.1 PROBLEM FORMULATION

The WSLRA evaluates risks to wildlife receptors of concern (ROCs) from ingestion of COPCs measured in environmental media for specified exposure pathways. Receptors, protection goals, exposure pathways, and methods for identification of COPCs are summarized below, and the conceptual model is shown in Figure 3.

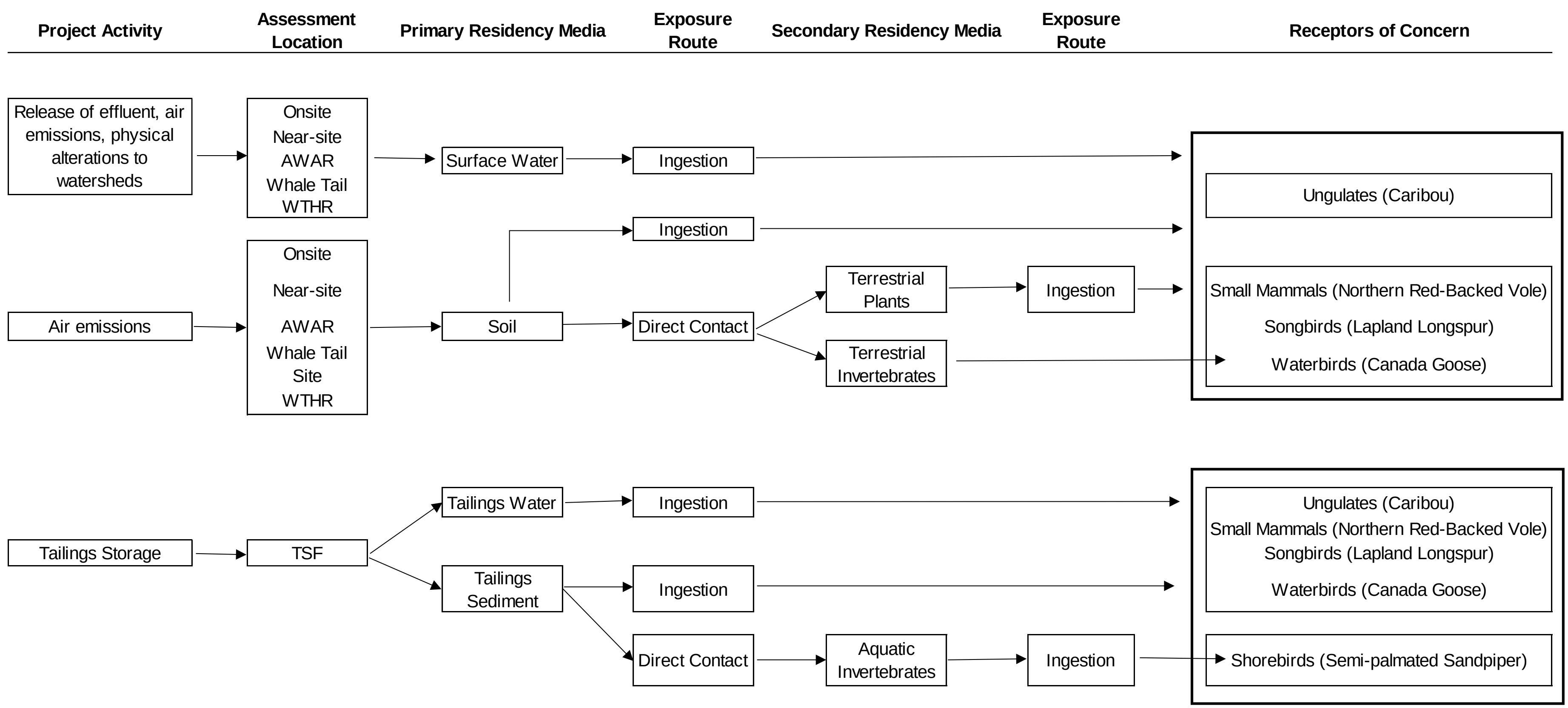

Figure 3. Wildlife risk assessment conceptual model.

2.1.1 Receptors of Concern (ROCs)

The original Meadowbank WSLRA (Azimuth, 2006) considered four groups of ROCs: ungulates, small mammals, waterfowl and songbirds. These choices were determined from the project's initial FEIS (Cumberland, 2005), which included discussions with stakeholders, public meetings, traditional knowledge and experience from other mines. Specifically, the WSLRA focussed on caribou, Canada goose, Lapland longspur and northern red-backed vole as representative species. An ecological description of the area and detailed descriptions of the biology of each of these receptors can be found in Azimuth (2006). This updated assessment framework also includes an assessment of risks to all original receptors, plus shorebirds (as represented by semi-palmated sandpiper) from contaminants within the TSF, based on a commitment made during the Whale Tail Mine project Final Hearing, following discussions with Environment and Climate Change Canada (ECCC) (Technical Meeting Commitment 45, as described in Golder, 2019b.

2.1.2 Protection Goals and Endpoints

Since the ROCs identified are not rare or endangered species, protection at the population level was determined to be appropriate (Azimuth, 2006). The assessment endpoint is no adverse effect of COPCs on populations of caribou, Canada goose, Lapland longspur, northern red-backed vole, and semi-palmated sandpiper.

As a result, ecotoxicological benchmarks used in the risk characterization will be lowest observable adverse effect levels (LOAELs), which are generally considered to be appropriate for determining risk at the population level (Azimuth, 2006). Toxicity reference value (TRV) selection is further described in Section 2.3.

2.1.3 Exposure Pathways

The following exposure pathways will be investigated, as shown in Figure 3. The term "tundra pathways" is used throughout to refer to evaluations conducted for samples collected at onsite, near-site, AWAR, Whale Tail Mine and WTHR locations (Figures 1 and 2), as opposed to the "TSF pathway" which assesses exposure to contaminants directly from the TSF.

Small mammals (Northern Red-Backed Vole):

- TSF pathway: ingestion of tailings water
- Tundra pathways: ingestion of insects, plants, water; incidental ingestion of soil

Ungulates (Caribou):

- TSF pathway: ingestion of tailings water
- Tundra pathways: ingestion of plants, water; incidental ingestion of soil

Songbirds (Lapland Longspur):

- TSF pathway: ingestion of tailings water
- Tundra pathways: ingestion of insects, plants, water; incidental ingestion of soil

Waterfowl (Canada Goose):

- TSF pathway: ingestion of tailings water
- Tundra pathways: ingestion of insects, plants, water; incidental ingestion of soil

Shorebirds (Semi-Palmated Sandpiper):

- TSF pathway: ingestion of tailings water and tailings benthic invertebrates; incidental ingestion of tailings sediment
- Tundra pathways: not evaluated[1]

Inhalation and dermal absorption of metals are generally considered to be insignificant in comparison to exposures through ingestion (USEPA, 2005), so they are not considered in the Meadowbank WSLRA.

2.1.4 Contaminants of Potential Concern (COPCs)

Potential sources of contaminants are indicated in Section 1.5. In the baseline WSLRA, Azimuth (2006) identified COPCs for risk characterization based on the chemical composition of the identified dust sources, the predicted effects of effluent on water quality in Third Portage Lake, and a review of metals regulated under MDMER (see Azimuth, 2006, Section 2.5 for details). Projected concentrations of metals in four dust sources (roads, waste rock and tailings) that exceeded the 90^{th} centile of baseline soil concentrations or CCME Soil Quality Guidelines for the Protection of Environmental and Human Health were included as COPCs for the Meadowbank Mine evaluation. For water, manganese and cadmium were included because they were predicted to exceed CCME Water Quality Guidelines for the Protection of Aquatic Life (cadmium) or aesthetic drinking water objectives (manganese). Although not predicted to exceed guidelines, five metals regulated under MDMER (arsenic, copper, lead, nickel and zinc) and mercury were included in the assessment because they were found to be of concern to the general public in the Arctic.

For the Whale Tail Mine assessments (Golder, 2016 & 2019a), wildlife COPCs were identified by screening predicted concentrations in primary residency media (soil and water; tailings sediment and water) against established guideline values (primarily CCME sources), or maximum measured baseline concentrations +10% (where baseline was greater than the guideline value).

For Meadowbank WSLRAs completed in 2011, 2014 and 2017, quantitative risk characterization (hazard quotient calculation) was performed for all COPCs identified historically in Azimuth (2006). However, beginning in 2021, measured concentrations in primary residency media (soil and lake water; and TSF sediment and water - Figure 3) collected through the WSLRA field program at sites around the Meadowbank Complex (Section 2.2.2) have been initially screened against established regulatory guideline values (described below) and/or maximum measured background values + 10%, as in Golder (2019a,b) to identify COPCs.

Parameters selected for screening will include all metals with CCME Soil Quality Guidelines for the Protection of Environmental and Human Health (CCME, 2022a) or CCME Canadian Water Quality Guidelines for the Protection of Agriculture (livestock watering - CCME, 2022b), plus COPCs identified

[1] Based on discussions with ECCC during the permitting process for the Whale Tail Mine Expansion Project, assessment of risk to shorebirds was required to be added for the TSF pathway only (as in Golder, 2019b).

in previous Meadowbank WSLRAs (manganese and strontium were identified as COPCs in Azimuth (2006) because predicted concentrations in mine rock dust sources exceeded baseline soil concentrations; cyanide was identified as a COPC for the TSF pathway in Golder (2019b)). Certain chemicals which are controlled through best management practices and which were not addressed in the baseline SLRA include petroleum hydrocarbons, dioxins, nitrates, ammonia and PAHs. For each source of these chemicals, best management practices are in place and environmental exposures are not expected to occur.

The corresponding primary soil and water quality guidelines selected for this screening at this time are the same as those used in the Whale Tail Mine Expansion Project HHERA (Golder, 2019a,b):

Soil/Sediment[2]:

- Canadian Council of Ministers of the Environment Soil Quality Guidelines for the Protection of Environmental and Human Health (SQG_E – Residential Land Use) (CCME, 2022a)

Water:

- Livestock Watering Guidelines from the CCME Water Quality Guidelines for the Protection of Agriculture (CCME, 2022b)
- Livestock Watering Guidelines from the British Columbia Ministry of Environment (BC MOE, 2021)

Where guideline values are unavailable from these sources for the screening parameters, alternate appropriate sources will be referenced (e.g. CCME, 2022c; BC CSR, 2021a). Screening guidelines will be updated as new reference values become available, with changes described in each SLRA report.

Any parameters with measured concentrations exceeding screening values are retained as COPCs for quantitative risk characterization. This approach is consistent with the recent ecological risk assessments for the Whale Tail Mine (Golder, 2016 & 2019a,b).

2.2 EXPOSURE ASSESSMENT

Exposure assessment is used to calculate the dose of each identified COPC received by each ROC for each complete exposure pathway. The exposure assessment uses the food chain model developed by Azimuth (2006) with updates as in Golder (2019b), as described below. The model was developed to calculate daily exposure to contaminants in the various study locations based on COPC concentrations in exposure media, dietary preferences, ingestion rates and dose-adjustment factors.

Estimated daily intake of each COPC is calculated separately for each study location as:

[2] In the absence of sediment guidelines that are protective of semi-aquatic birds and mammals, guidelines for soil that are protective of wildlife are used for comparison purposes.

$$EDI = \sum_{w,s,f} (I_{w,s,f} \times C_{w,s,f}) \times BF \times T$$

Where:

EDI = estimated daily intake (mg/kg body weight·d)

$I_{w,s,f}$ = intake of water, soil/sediment and food items (L/kg ww·d; kg dw/kg ww·d; kg dw/kg ww·d)

$C_{w,s,f}$ = concentration of COPC in water, soil/sediment and food items (L/kg ww·d; kg dw/kg ww·d; kg dw/kg ww·d)

BF = biotransfer factor (absorption factor) – assumed to be 100%

T = proportion of time in area (%)

Each component is described below.

2.2.1 $I_{w,s,f}$ - Intake of Water, Soil/Sediment, and Food

Water, food and soil/sediment ingestion rates used in the assessments are shown in Table 1. All intake parameters are considered to be conservative. Water and food ingestion rates were derived from species profiles or allometric equations in USEPA (1993), as described in Table 1. Soil ingestion rates for Canada goose and northern red-backed vole are also from USEPA (1993). Sediment ingestion rates for semi-palmated sandpiper are from Beyer et al. (1994). Although Beyer et al. (1994) was referenced as the source of most soil ingestion rates in the Meadowbank baseline assessment, the species chosen to represent Caribou and Lapland Longspur were not indicated. The soil consumption rate for Caribou was therefore increased in subsequent Meadowbank assessments from 2% of dry food consumption to 5%, which is the general rate for mammals in Beyer et al. (1994), as used in (Senes, 2008). Similarly, the soil ingestion rate for Lapland longspur was increased from 2% in the baseline assessment to 7%, based on Hansen et al. (2011). This study identified a rate of 0.7% for Swainson's thrush, a ground-dwelling songbird that primarily feeds on flying insects and berries. A 10x safety factor was applied because Swainson's thrush is a foliage-gleaner, while Lapland longspur is considered a ground-forager (Cornell University, 2011). This factor is considered to be conservative however, because Lapland longspur does not scratch the ground to uncover food items as other ground foragers do (Harrison, 1967).

Table 1. Body weight (BW), water intake (I_{water}), soil intake (I_{soil}), and wet and dry (I_{food}; FI) food intake for the identified ROCs.

Parameter	Units	Value	Reference	Notes
Northern Red-backed Vole				
BW	kg wet	0.02	Nagorsen (2005)	Smallest body weight used
I_{water}	L/kg wet/day	0.253	USEPA (1993)	Species profile data for the Prairie Vole
I_{soil}	kg dry/kg wet/day	0.0012	USEPA (1993)	Assumed 2.4% of dry food ingestion rate (similar to Meadow Vole)
I_{food}	kg wet/kg wet/day	0.135	USEPA (1993)	Species profile data for the Prairie Vole
FI	kg dry/kg wet/day	0.049	Not available	Moisture in food assumed to be 64%

Parameter	Units	Value	Reference	Notes
				as per diet moisture calculation
Caribou				
BW	kg wet	75	Dauphine (1976)	Smallest body weight used
I_{water}	L/kg wet/day	0.064	USEPA (1993)	Based on allometric equation for all mammals (L/day) $(0.099*(BW)^{0.90})$
I_{soil}	kg dry/kg wet/day	0.0013	Beyer et al. (1994)	Assumed 5% of dry food ingestion rate (general rate for mammals)
I_{food}	kg wet/kg wet/day	0.047	Not available	Moisture in food assumed to be 43% as per diet moisture calculation
FI	kg dry/kg wet/day	0.027	USEPA (1993)	Based on total dry food intake for herbivorous mammals (g/day) $(0.577*(BW)^{0.727})$
Lapland Longspur				
BW	kg wet	0.023	Cornell University (2011)	Smallest body weight used
I_{water}	L/kg wet/day	0.205	USEPA (1993)	Based on allometric equation for all birds (L/day) $(0.059*(BW)^{0.67})$
I_{soil}	kg dry/kg wet/day	0.0174	Hansen et al. (2011)	Assumed 7% of dry food ingestion rate (rate of Swainson’s thrush +10x safety factor)
I_{food}	kg wet/kg wet/day	0.654	USEPA (1993)	Moisture in food of insectivorous birds; assumed 62% as per diet moisture calculation
FI	kg dry/kg wet/day	0.249	USEPA (1993)	Based on total dry food intake for passerine birds (g/day) $(0.398*(BW)^{0.850})$
Canada Goose				
BW	kg wet	2.000	Mowbray et al. (2002)	Smallest body weight used
I_{water}	L/kg wet/day	0.044	USEPA (1993)	Species profile data for Canada Goose
I_{soil}	kg dry/kg wet/day	0.0009	USEPA (1993)	Assumed 8.2% of dry food ingestion rate
I_{food}	kg wet/kg wet/day	0.032	USEPA (1993)	Species profile data for Canada Goose
FI	kg dry/kg wet/day	0.011	Not available	Moisture in food assumed to be 66% as per diet moisture calculation
Semi-Palmated Sandpiper				
BW	kg wet	0.0235	ECCC (2019)	Site specific body weight provided from ECCC in teleconference July 10, 2019
I_{water}	L/kg wet/day	0.188	USEPA (1993)	Allometric scaling for birds (L/day) = $0.059\ Wt^{0.67}$ (kg)
$I_{sediment}$	kg dry/kg wet/day	0.059	Beyer et al. (1994)	30% of dry food ingestion rate
I_{food}	kg wet/kg wet/day	1.0	USEPA (1993)	Allometric scaling for birds (g (dw)/day) = $0.648\ Wt^{0.651}$ (g); assumed moisture content of 80% per Senes (2008)

Parameter	Units	Value	Reference	Notes
FI	kg dry/kg wet/day	0.197	USEPA (1993)	Allometric scaling for birds (g (dw)/day) = 0.648 $Wt^{0.651}$ (g); assumed moisture content of 80% per Senes (2008)

2.2.2 $C_{w,s,f}$ - Dietary Concentrations of COPCs

Dietary concentrations of COPCs in drinking water, soil/sediment, and food items are calculated as:

Cs = [soil]; (measured directly)

Cw = [drinking water]; (measured directly)

$C_{food\ items} = \sum_{food\ items}$ ([food item] x DP(%)); (measured or modeled – Section 2.2.2.1)

Where:

DP = dietary preference (% of food item in diet of the ROC – Section 2.2.2.2)

Each component is described below.

2.2.2.1 Concentrations in Ingested Media ([soil], [drinking water], [food items])

For tundra exposure pathways, concentrations of COPCs in lake water, soil, and plant tissue (food items: sedges, lichens, berries) are measured directly in samples collected at specified locations around the Meadowbank Complex in assessment years (Figures 1 & 2). Historically (through 2017), five samples of each media type were collected from each location. Beginning in 2021, three of the five stations will be randomly selected and sampled in any monitoring year. This slightly reduced sampling effort is warranted since to date, no unacceptable mine-related risk has been identified (2011, 2014, 2017, 2021 WSLRA assessments), and recent risk assessments for the Whale Tail site (Golder, 2016; Golder, 2019a; Golder, 2019b) have not identified any anticipated unacceptable risk.

Lake water samples from the Core Receiving Environment Monitoring Program (CREMP) will be used in the WSLRA analyses for drinking water in tundra pathways (assessment lakes and 2021 sites shown in Figure 1 – specific sites within each lake change annually). Onsite (Meadowbank Mine) concentrations will be from samples collected in Second Portage Lake (SPL) and the east and north basins of Third Portage Lake (TPE, TPN). AWAR concentrations will be from samples collected in TPN. Near-site concentrations will be from samples collected in Tehek Lake (TE). Whale Tail Mine concentrations will be from samples collected in Whale Tail Lake South and Kangislulik (formerly Mammoth) Lake. Whale Tail Haul Road concentrations will be from samples collected in Pipedream Lake (PDL). External reference samples are from Inuggugayualik Lake (INUG) and PDL. Exact coordinates are subject to slight changes each year – see CREMP Plan for details.

For the TSF exposure pathway, water quality samples (ponded North and South Cell Tailings water) are collected monthly during the open water season (typically June – October) under regular mine-site monitoring programs. Results for the WSLRA monitoring year will be used in the assessment. Historically (2021 WSLRA Report and Golder (2019b)), exposure to contaminants in tailings sediment were assessed using monthly analysis results for direct mill effluent. Moving forward, tailings beach sediment will be preferentially sampled in the WSLRA monitoring year, as it is more representative of exposure media.

For the identified COPCs in tundra pathways (see Section 2.1.4), the upper 95% confidence limit of the mean (UCLM) concentrations in soil and plant tissue for each assessment location will be used for food chain modeling. If measured values are below the laboratory detection limit, a value of one half the detection limit will be used in calculations. Based on published literature, methyl mercury is assumed to comprise 1% of total mercury in water and soil, and 34% of total mercury in plant tissue, and inorganic mercury = total – methyl mercury (Azimuth, 2006).

For the TSF pathway, maximum measured values in tailings sediment and ponded TSF water were initially planned to be used in EDI calculations, as in Golder (2019b). This approach is more conservative than the UCLM method and was adopted because of the relatively low sample size for these media (generally one sample per month). However, since exposure concentrations for sediment are now measured in a suite of tailings beach sediment locations (10+) during the in-migration period in each WSLRA monitoring year, rather than a single monthly sample of mill effluent, a measure of central tendency (e.g. mean measured concentrations, or UCLM) will be used in EDI calculations for the TSF pathway, as for the tundra pathway.

Concentrations of COPCs in terrestrial insects consumed by certain ROCs (Section 2.2.2.2) are not measured, but are modeled from soil concentrations using published bioaccumulation models for arsenic, cadmium, copper, lead, and zinc (Sample and Arenal, 2001; as described in Azimuth, 2006):

ln[insect] = B0 + B1(ln[soil]); concentrations are expressed in mg/kg dry weight

This method is particularly conservative, because the modeled factors are for ground insects whereas the songbird population in this assessment consumes primarily flying insects. A bioaccumulation factor (BAF) of 1 is assumed for all remaining COPCs, which is also considered to be very conservative.

For benthic invertebrates that are potentially ingested by semi-palmated sandpiper in the TSF pathway, BSAFs from the literature will be used to estimate whole-body tissue concentrations based on measured sediment concentrations as:

[benthic invertebrate; mg/kg ww] = BSAF x [sediment; mg/kg dw]

BSAFs identified to date from literature review are shown in Table 2, with updates to prioritize empirically-derived values. Specifically, BSAFs were obtained from the following sources, in order of preference:

1. Bechtel-Jacobs (1998) – BSAFs available for As, Cd, Cr, Cu, Pb, Hg, Ni, Zn
    - As recommended in Bechtel-Jacobs (1998) for screening-level assessment (conservative BSAFs), the selected values represent the 90^{th} centile of the BSAF datasets developed by the authors for each contaminant from literature review. These primary study datasets include only freshwater invertebrates, and only results from studies using extraction methods standard in environmental assessment. Many studies included are from Canadian locations.
2. Jacques Whitford (2009) – BSAFs for Sb, Ba, Be, Co, Se, V
    - BSAFs for these parameters were derived from four primary sources (Haus et al. 2007, Hamilton et al. 2002, Garn et al. 2001, and Welsh and Maughan, 1993), as described in Jacques Whitford (2009): "*The BSAFs … were calculated as the arithmetic mean of literature acquired values when the range did not exceed one order of magnitude and as the geometric mean if the BSAF values acquired varied by more than one order of magnitude.*"
3. USEPA (1999) – Th, CN

- For both of these parameters, no empirically-derived BSAFs were identified in the literature, but USEPA (1999) recommends a value representing the average for all metals with empirical datasets (0.9).

For all other COPCs, a BSAF of 1 is assumed, as in previous assessments.

Table 2. Biota-sediment accumulation factors (BSAFs) used for estimating whole-body concentrations of COPCs in benthic invertebrates (mg/kg wet tissue per mg/kg dry sediment). Note: a moisture content of 80% was assumed in dry to wet weight conversions from literature values, where needed (Senes, 2008).

Parameter	BSAF	Reference
Antimony	0.0113	Jacques Whitford, 2009
Arsenic	0.14	Bechtel-Jacobs, 1998
Barium	0.137	Jacques Whitford, 2009
Beryllium	0.132	Jacques Whitford, 2009
Cadmium	1.60	Bechtel-Jacobs, 1998
Chromium	0.09	Bechtel-Jacobs, 1998
Cobalt	0.002	Jacques Whitford, 2009
Copper	1.05	Bechtel-Jacobs, 1998
Lead	0.121	Bechtel-Jacobs, 1998
Manganese	1	N/A
Mercury	0.574	Bechtel-Jacobs, 1998
Molybdenum	1	N/A
Nickel	0.46	Bechtel-Jacobs, 1998
Selenium	0.626	Jacques Whitford, 2009
Strontium	1	N/A
Thallium	0.9	USEPA, 1999
Tin	1	N/A
Uranium	1	N/A
Vanadium	0.015	Jacques Whitford, 2009
Zinc	1.505	Bechtel-Jacobs, 1998
Cyanide	0.9	USEPA, 1999

2.2.2.2 Dietary Preferences (DP)

For tundra pathways, the proportions of food items (sedge, lichen, berries, insects, benthic invertebrates – Table 3) contributing to the diet of each receptor for each assessment location were determined using literature reviews in Azimuth (2006). Sedges, lichens and berries are considered surrogates for all plant matter ingested by the ROCs.

For the TSF pathway, as in Golder (2019b), semi-palmated sandpiper is assumed to consume drinking water and benthic invertebrates from the TSF. All other receptors are assumed to consume water only.

Table 3. Proportion of dietary items obtained from the WSLRA assessment locations for the receptors of concern.

Dietary Item	Northern Red-Backed Vole	Caribou	Lapland Longspur	Canada Goose	Semi-Palmated Sandpiper
Tundra Pathways					
Sedges	55%	30%	25%	50%	-
Lichens	0%	65%	0%	0%	-
Berries	40%	5%	5%	45%	-
Insects	5%	0%	70%	5%	-
Total Food	100%	100%	100%	100%	-
Drinking Water	100%	100%	100%	100%	-
TSF Pathway					
Benthic Invertebrates	-	-	-	-	100%
Drinking Water	100%	100%	100%	100%	100%

2.2.3 Biotransfer Factor

The uptake efficiency factor (biotransfer or absorption factor) describes the proportion of the COPC that is absorbed into the animal from any ingested sources. Uptake efficiency was conservatively assumed to be 100% for all COPC/receptor combinations and/or accounted for in TRV determination.

2.2.4 Time in Area

Territory size (foraging range) affects the proportion of an animal's diet that could be affected by mine-related contaminants. In the baseline assessment for Meadowbank (Azimuth, 2006), an adjustment factor for foraging range was not applied (animals were assumed to spend 100% of time in the study area). For subsequent assessments, the only ROC assumed to spend 100% of its time in the study area is the northern red-backed vole, because of its small territory size. Canada geese, and Lapland longspur are migratory species, and the fraction of time spent in the study area for those species is estimated at 33%, based on the 2008 Screening Level Environmental Effects Assessment for the Kiggavik Project (Senes, 2008).

The time caribou spend in the study area (12%) was determined through an examination of collared caribou from the Meadowbank region, which found that any one animal spent no more than a maximum of 12% of the year within 25 km of the minesite (Martin Gebauer and Jason Shaw, personal communication, March 2012). This is similar to the estimate of 10% used in the 2004 assessment of the Lupin minesite (Golder, 2004).

For the TSF, time-in-area factors from Golder (2019b) were used. While semi-palmated sandpiper are migratory and estimated to spend 33% of the year in the minesite area (Senes, 2008), they are expected to spend a smaller proportion of this time interacting with the TSF, since best management practices are in place to actively discourage wildlife from this area. During breeding season, inspections are performed, and birds are deterred from the open-water areas of the TSF through the use of personnel presence, decoys, noise cannons, and flares as necessary. While bird presence around the TSF could occur for up to 2 weeks in the very early spring, prior to ice-off on natural lakes, very few birds are observed in this area after that time. Therefore, the proportion of time that semi-palmated sandpiper are potentially exposed to COPCs in the TSF is conservatively over-estimated at 8% (i.e. 4 weeks per year). The same factor was applied for all other receptors except vole, based on the ice-free season and that voles are not actively deterred from the TSF as the other receptor types are.

Risk will be characterized for small-territory ROCs (northern red-backed vole, Canada goose and Lapland longspur) for Meadowbank minesite (onsite), near-site, AWAR, TSF, Whale Tail Pit, Whale Tail Haul Road, and external reference locations separately, in order to determine whether those animals choosing territories at any mine-related location are at increased risk compared to those choosing territories at nearby reference locations. Exposure data for main minesite and near-site locations will be combined for caribou because they can readily roam between the onsite and near-site locations in the course of a day.

Time-in-area adjustment factors are summarized in Table 4.

Table 4. Time-in-area assumption for each study area and ROC.

Study Area	Northern Red-Backed Vole	Caribou	Lapland Longspur	Canada Goose	Semi-Palmated Sandpiper
Onsite	100%	12%	33%	33%	-
Near-site	100%		33%	33%	-
AWAR	100%	12%	33%	33%	-
Whale Tail Pit Area	100%	12%	33%	33%	-
Whale Tail Haul Road	100%	12%	33%	33%	-
External Reference	100%	12%	33%	33%	-
TSF	25%	8%	8%	8%	8%

2.3 TOXICITY ASSESSMENT

Toxicity reference values (TRVs) used to date in the Meadowbank assessments are provided in Appendix A. These were collated in Azimuth (2006) unless otherwise indicated, from a review of the literature; mainly from Sample et al. (1996). This still represents one of the most comprehensive and commonly used sources available for wildlife toxicity reference values and has been used in other similar assessments for this region (e.g. Senes, 2008). In order to ensure the selected TRVs were relevant to the Meadowbank site and the conditions of that risk assessment, several criteria were used in the baseline assessment in screening toxicity studies. These included selecting values from studies conducted on species of similar phylogeny (i.e. bird or mammal), and selecting studies that examined individual or population-level effects over chronic time periods. The following describes TRV selection, as performed by Azimuth (2006):

> The TRVs chosen for use in the risk characterization include both no observable adverse effect levels (NOAELs) and lowest observable adverse effect levels (LOAELs) when available. If effects concentrations were reported in terms of food concentrations, these were converted to dose. If a LOAEL was reported but no NOAEL could be determined, it was estimated as 1% of the LOAEL (as in Sample et al. 1996, Chapman et al. 1998). LOAELs cannot be estimated if only a NOAEL is available. Since the protection goal of

this risk assessment no adverse effect of COPCs on populations of the ROCs, LOAELs are the most relevant TRV, and are used in the final risk estimate.

Where toxicity information was found for multiple forms of a contaminant, the one with the greatest toxic potency was chosen. TRVs for chromium-VI were available for mammals, but only chromium-III was available for birds. No NOAELs or LOAELs were available for total mercury. Mammalian LOAELs were not available for inorganic mercury or beryllium. Avian LOAELs were not available for uranium or vanadium. Avian NOAELs were not available for antimony and beryllium and were extrapolated from the mammalian values. The avian LOAEL for antimony was extrapolated from the mammalian value.

While previous versions of this plan and WSLRAs in 2011 – 2017 included allometric scaling to adjust mammalian TRVs from test species to ROCs, those were removed beginning in Version 5, as recommended in Allard et al. (2010), and to align with Golder (2019a,b) methods.

The TRV for cyanide used for the TSF pathway was obtained from Ma and Pritsos (1997), as applied for another Northern shorebird, the common snipe, in Golder (2004).

TRVs presented here will be reviewed and updated as necessary in future assessments.

2.4 RISK CHARACTERIZATION

Risk characterization compares predicted exposure concentrations with the toxicity reference values from the literature, using the hazard quotient approach. Hazard quotients for all study areas (main Meadowbank minesite (onsite), near-site, AWAR, Whale Tail Pit, Whale Tail Haul Road, TSF, and external reference) will be calculated as:

$$HQ = EDI / TRV$$

Where:

EDI = estimated daily intake (mg/kg body weight·d)

TRV = toxicity reference value (mg/kg body weight·d)

Because of the conservative assumptions included at this level of assessment, there is generally considered to be a high degree of certainty associated with results indicating negligible risk. A hazard quotient > 1 indicates the possible need for more in-depth assessment, including analysis of assumptions used. However, when HQ values exceed 1 for both the external reference (or baseline) and study areas, and are of similar magnitude, it may be assumed that the receptor is adapted to the measured exposure level, or that the assumptions used in calculating the HQ have resulted in an over-estimation of risk (Dominion Diamond, 2015).

HQ values and a characterization of risk for each ROC will be provided in the assessment report.

2.5 UNCERTAINTY ASSESSMENT

The assumptions included in each section of the assessment will be discussed, along with implications for over- or under-estimating risk.

3 HUMAN HEALTH – COUNTRY FOODS ASSESSMENT

3.1 PROBLEM FORMULATION

The $HHRA_{country\ foods}$ assessment will re-evaluate risk to human receptors for country foods exposure pathways identified in the pre-construction HHRA (Wilson, 2006) and follow-up assessments (HHRAs conducted in 2011, 2014, 2017, and 2021), making use of environmental samples collected through the Wildlife Assessment (Section 2.2.2). The conceptual model for country foods consumption is shown in Figure 4.

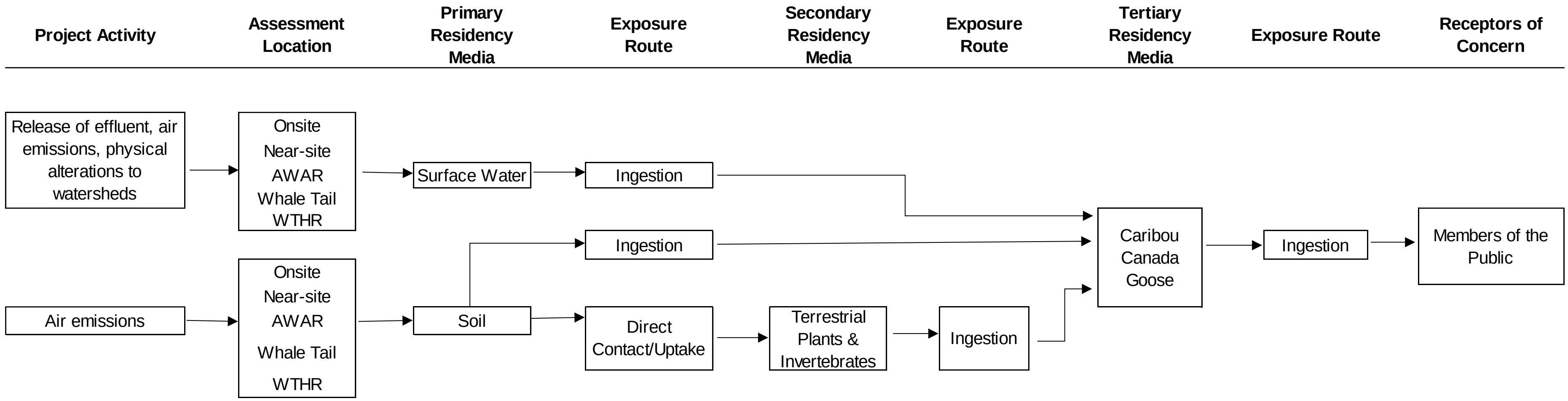

Figure 4. Human health (country foods) risk assessment conceptual model.

3.1.1 Exposure Pathways

From reviews of oral testimony collected in 2005 (Traditional Knowledge Report as part of the Meadowbank FEIS - Cumberland, 2005), Wilson (2006) found caribou meat, kidney and liver, Canada goose meat and lake trout to be the food items most representative of local country foods consumption patterns. Lake trout was included in the baseline assessment because they represent the majority of fish in the project lakes. However, since a no-fishing policy was put in place for workers and fish from project lakes are non-migratory, consumption rates of fish impacted by the mine site were expected to be negligible. Analyses of risk from fish consumption were therefore excluded from subsequent Meadowbank risk assessments[3]. Although it was determined that local residents may consume wild berries, it was found to be unlikely that they would be harvested from the mine site area due to distance, the fact that public access is prohibited past km 85 on the AWAR, and abundance of this food source closer to Baker Lake. Consumption of berries was therefore not evaluated in the baseline assessment or subsequent updates. Following HC recommendations received via the NIRB process (June 8, 2023), Agnico Eagle continues to evaluate the potential addition of berry consumption to the HHRA pathway. Berries are currently collected as part of the WSLRA/HHRA field program, which will next occur as scheduled in 2024. Finally, although risk analyses for consumption of Canada goose are maintained in this Plan, it is noted that only 7% of the population of Baker Lake was found to consume this item, at a frequency of less than 1 day per month (Areva, 2011).

The following food items are therefore included in the $HHRA_{country\ foods}$ evaluation:

- Caribou meat (muscle)
- Caribou kidney
- Caribou liver
- Canada goose meat (muscle)

Assessed exposure pathways for these country food items are identified in Figure 4.

3.1.2 Potential Receptors

For consistency with Wilson (2006), potential receptors are considered to be a young child or toddler (age 6 months – <5 yrs) and an adult consumer of country foods. These receptors are considered to be representative and protective of the general population.

3.1.3 Contaminants of Potential Concern

As described in Section 2.1.4, pre-construction wildlife risk assessments for the Meadowbank Mine identified COPCs according to predicted concentrations in dust sources, effluent, and a review of metals regulated under MDMER (see Azimuth 2006, Section 2.5 for details). These parameters were also

[3] As required under NIRB Project Certificate No. 008 Condition 63, Agnico evaluates concentrations of mercury in fish tissue at the Whale Tail Mine under the Mercury Monitoring Plan. Results are provided in the Meadowbank Complex Annual Report to the NIRB. A summary of this program and results will be provided in the HHRA report.

assessed as COPCs in the pre-construction $HHRA_{country\ foods}$ (Wilson, 2006), and subsequent 2011, 2014, and 2017 assessments under operational conditions.

For the Whale Tail Mine HHERAs (Golder, 2016 & 2019a), COPCs were identified by screening predicted concentrations in primary residency media (soil and water) against established regulatory guideline values that are protective of human health, or maximum measured baseline values +10% (where baseline was greater than the guideline value).

Beginning in the 2021 assessment, human health COPCs have been identified for risk characterization using the screening approach described in Golder (2019a), which is consistent with the wildlife assessment approach (Section 2.1.4). Measured concentrations in primary residency media (e.g. soil and lake water; Figure 4) collected through the WSLRA field program at sites around the Meadowbank Complex (Section 2.2.2) will be initially screened against established regulatory guideline values (described below) and/or maximum measured background values, to identify COPCs.

Parameters selected for screening will include all metals with CCME Soil Quality Guidelines for the Protection of Environmental and Human Health (CCME, 2022a) or Health Canada Canadian Water Quality Guidelines for Drinking Water (Health Canada, 2020), plus any COPCs identified in previous assessments (manganese and strontium were identified as COPCs in 2006 because concentrations in onsite dust sources were predicted to exceed baseline soil concentrations).

The corresponding primary soil and water quality guidelines selected for this screening are the same as those used in the Whale Tail Mine Expansion Project HHERA (Golder, 2019a):

Soil:

- Canadian Council of Ministers of the Environment Soil Quality Guidelines for the Protection of Environmental and Human Health (SQG_H – Residential Land Use) (CCME, 2022a)

Water:

- Health Canada Canadian Water Quality Guidelines for Drinking Water (Health Canada, 2020)

Where guideline values are unavailable from these sources for the screening parameters, alternate appropriate sources will be referenced (e.g. BC CSR, 2021a,b).

Any parameters with measured concentrations exceeding screening values will be retained as COPCs for quantitative risk characterization.

3.2 EXPOSURE ASSESSMENT

Exposure assessment is used to calculate the dose of each COPC received by country foods consumers. For consistency, the exposure assessment follows methods from Wilson (2006), with updates as described below, and is based on the food chain model for caribou and Canada goose developed by Azimuth (2006).

Daily exposure to COPCs from consumption of country foods is calculated based on Health Canada (2021a) as:

$$Dose = C_F \times IR_F \times RAF_{ORAL} / BW$$

Where:

Dose = estimated daily intake of COPC from consumption of food item; µg/kg bw·d

C_F = concentration of COPC in food items (caribou meat, kidney, liver, goose meat); mg/kg ww

IR_F = consumption rate of food item; g/day

RAF_{ORAL} = relative absorption factor (assumed to be 1)

BW = body weight of person; kg

Each component is described below.

3.2.1 C_F - COPC Concentrations in Country Food Items

To estimate risk from consumption of country foods, concentrations in each food item (caribou meat, caribou organs, Canada goose meat) are modelled from the soil, lake water, sedge, lichen, and berry samples collected as described in Section 2.2.2.

Estimated daily intake (EDI) by caribou and Canada goose is calculated as described in Section 2.2, except source concentrations used for $HHRA_{country\ foods}$ food chain modeling are maximum measured values for each location, as recommended by Health Canada (2021a), as opposed to the 95% UCLM values used in the baseline HHRA assessment and WSLRA. Depending on the available dataset, the UCLM or a measure of central tendency may be used, with justification (Health Canada, 2021a).

Modelled tissue concentrations for each food item are then calculated as follows:

3.2.1.1 Caribou Muscle

To estimate concentrations of COPCs in caribou muscle, EDIs for Caribou are multiplied by body weight and feed-to-muscle biotransfer factors from the literature.

Caribou muscle concentrations (C_M) are calculated as:

$$C_M = EDI_C \times W_C \times BTF$$

Where:

C_M = Concentration in muscle tissue (meat); mg/kg ww

EDI_C = estimated daily intake of COPC by caribou; mg/kg ww·d

W_C = caribou weight; kg (75 kg; Dauphine, 1976)

BTF = biotransfer factor (feed to muscle; beef); d/kg ww (Appendix A; or other appropriate referenced source)

3.2.1.2 Caribou Kidney and Liver

Concentrations of COPCs in caribou kidney and liver have historically been estimated from muscle concentrations using muscle-to-kidney and muscle-to-liver transfer factors for caribou provided by Gamberg (2012) (Appendix A). While these factors were unpublished, they are from a large scale and long-term study that is part of the Northern Contaminants Program. These values differ from the 2006 assessment, in which only kidney transfer factors calculated from mean concentrations were available (mainly for moose), and these were assumed to be representative of both organs in caribou. Factors will be reviewed and sources updated as available at the time of the next assessment.

Kidney concentrations (C_K) and liver concentrations (C_L) were calculated as:

$$C_K \text{ or } C_L = C_M \times BTF$$

Where:

C_K = concentration of COPC in caribou kidney; mg/kg ww

C_L = concentration of COPC in caribou liver; mg/kg ww

C_M = concentration of COPC in caribou muscle; mg/kg ww

BTF = transfer factor (muscle to organ; caribou) (Gamberg, 2012, as in Appendix A; or other appropriate referenced source)

3.2.1.3 Canada Goose Muscle

To estimate concentrations in Canada goose muscle, estimated daily intake rates were multiplied by Goose weight and feed-to-muscle biotransfer factors from the literature.

Goose muscle concentrations (C_{GM}) were calculated as:

$$C_{GM} = EDI_G \times W_G \times BTF$$

Where:

C_G = concentration of COPC in goose muscle; mg/kg ww

EDI_G = estimated daily intake of COPC by goose; mg/kg ww·d

W_G = weight of goose; 2 kg (Mowbray et al. 2002)

BTF = biotransfer factor (feed to muscle; chicken); d/kg ww (Appendix A)

3.2.2 IR_F – Intake (Consumption) Rate of Food Items

Based on a review of oral testimony and professional judgement, Wilson (2006) considered three scenarios (heavy, moderate and low consumption) for each food item, which will be carried forward to subsequent assessments unless otherwise indicated:

Caribou Muscle

- heavy consumption: 2 meals per day, 365 days per year
- moderate consumption: 3 meals per week, 52 weeks per year
- low consumption: 1 meal per month, 12 months per year

Caribou Organs

- heavy consumption: 1 meal per week, 52 weeks per year
- moderate consumption: 2 meals per month, 12 months per year
- low consumption: 1 meal per month, 12 months per year

Waterfowl Muscle

- heavy consumption: 3 meals per week, 52 weeks per year
- moderate consumption: 1 meal per week, 52 weeks per year
- low consumption: 1 meal per month, 12 months per year

Using a serving size of 200 g/serving for adults and 86 g/serving for toddlers (Richardson, 1997), Wilson (2006) estimated average daily consumption values. Since the derivation of consumption rates used in Wilson (2006) could not be traced to quantitative survey data, a review of the literature was performed in 2014 to verify that values were consistent with those available from published sources. This review indicated that some consumption rates for caribou meat may have been underestimated, while consumption rates for caribou organs and Canada goose may have been overestimated compared to values identified in local or regional surveys. As a result, consumption rates were updated to reflect data from these published sources, as described in Table 5. Scenarios of heavy, moderate and low consumption were maintained to reflect variety in preferences for country foods and the range of consumption rates identified in the literature.

Table 5. Food items, consumption scenarios, and estimated consumption rates. Toddler values are 43% of adult values (Richardson, 1997) unless otherwise indicated. Values will be updated with appropriate references as available at the time of reporting.

Food Item	Consumption Scenario	Consumption Rate (g/d)		Reference/Rationale
		Toddler	Adult	
Caribou meat (muscle)	Heavy	189.2	440	Highest daily intake in Kivalliq survey, as shown in Senes (2008), Table C-1
	Moderate	89.4	208	Average daily consumption in Nunavut survey (IHS, 2012); similar to estimated adult consumption rate for wild game in Richardson (1997) of 270 g/d
	Low	15	65	Average consumption for men and maximum consumption for toddlers in Baker Lake survey using ^{137}Cs body burdens in 1989-90 (Tracy and Kramer, 2000)
Caribou organ (kidney, liver)	Heavy	1.2	2.9	Harvest survey estimate: In 2010, there were 5020 caribou harvested by Baker Lake hunters (Areva, 2011) and an adult population of 1779 (GNBS, 2014). At a kidney weight of 187 g (Crete and Nault, 1989), maximum consumption would be of 2.9 g/d if adults consume all kidneys. This value is consistent with a Yukon survey by Schuster et al. (2011) indicating 3.2 g/d consumption of kidney, and 2.5 g/d consumption of liver. Larter and Nagy (2000) indicate 2.1 g/d for kidney. Chan et al. (2012) indicate 2.7 g/d for all ungulate organs combined.
	Moderate	0.6	1.3	Proportion of "heavy" caribou organ consumption in Wilson (2006)
	Low	0.3	0.7	Proportion of "heavy" caribou organ consumption in Wilson (2006)
Canada goose meat (muscle)	Heavy	9.9	23	Average daily consumption in Nunavut survey (IHS, 2012); also 95th centile of consumption in Chan et al. (2012) for 2 northern Manitoba reserves
	Moderate	5.6	13	Average daily consumption in Chan et al. (2012); also value used in Senes (2008) for ptarmigan consumption in Baker Lake
	Low	0.8	1.8	Based on proportion of "heavy" in Wilson (2006)

3.2.3 BW – Receptor Body Weight

The following body weight values from Richardson (1997; as recommended in Health Canada, 2021a) are used in the $HHRA_{country\ foods}$ assessments, unless otherwise indicated:

Toddler:	16.5 kg
Adult:	70.7 kg

3.3 TOXICITY ASSESSMENT

Toxicity reference values (TRVs) used in all previous $HHRA_{country\ foods}$ assessments are presented in Appendix A. TRVs will be reviewed and updated as appropriate at the time of future assessments (e.g. Health Canada, 2021b).

TRVs for metals are expressed as Tolerable Daily Intakes (TDIs) for non-cancer endpoints, and cancer slope factors for cancer endpoints. Inorganic arsenic was the only COPC identified as a potential carcinogen through the oral ingestion route.

3.4 RISK CHARACTERIZATION

3.4.1 Non-Cancer Risks

The risk characterization stage compares predicted exposure concentrations with published tolerable daily intake (TDI) values from the literature. Non-cancer risks were classified using hazard quotients (HQs), which are calculated as:

$$HQ = Dose / TDI$$

Where:

Dose = estimated daily intake from country foods; µg/kg bw·d

TDI = toxicity reference value; µg/kg bw·d

HQ values and a characterization of risk for each receptor and consumption scenario will be provided in the assessment report.

Based on recommendations in Health Canada (2021a) for preliminary quantitative risk assessment, a hazard quotient ≤ 0.2 indicates negligible risk when exposure from one pathway (i.e. country foods) is considered. This is different from the baseline $HHRA_{country\ foods}$ assessment in which negligible risk was associated with an HQ ≤ 1.

Because of the conservative assumptions included at this level of assessment, there is generally considered to be a high degree of certainty associated with results indicating negligible risk. For HQs greater than 0.2, adverse health effects will not necessarily occur. Rather, the assumptions and uncertainties associated with the risk analysis should be studied, and the possibility for more detailed or probabilistic assessment may be considered.

The main goal of this assessment is to determine potential effects of the Project over and above background concentrations. Therefore, when HQs exceeded the threshold of 0.2, results will be compared with external reference values or historical data in order to comment on the incremental effects of the Project on exposure to COPCs in country foods. Values are not directly compared to baseline HQs, because TDIs and some exposure parameters differ in certain cases, as described in the preceding sections.

It is noted that the magnitude of HQs is not necessarily proportional to risk, due to differences in underlying dose-response curves. While very large HQ values may indicate higher potential for risk, small differences in HQs cannot be considered to be significant (Ritter et al. 2002). The expectation of what represents a small difference will be explored individually for each food item/COPC where necessary, and expected significance of the incremental risk (difference in HQs) investigated through additional analysis of the underlying data where warranted.

3.4.2 Incremental Lifetime Cancer Risk

For carcinogenic substances (inorganic arsenic), risk is determined assuming lifetime exposure (no amortization) at adult consumption rates. Incremental lifetime cancer risk (ILCR), is calculated as:

$$ILCR = LADD \times SL$$

Where:

ILCR = incremental lifetime cancer risk

LADD = estimated lifetime average daily dose from country foods; µg/kg bw·d

SL = slope factor; $(\mu g/kg \cdot d)^{-1}$

ILCR values and a characterization of risk for each receptor and consumption scenario will be provided in the assessment report.

Based on recommendations in Health Canada (2021a), cancer risk is found to be “essentially negligible” (*de minimis*) when ILCR $\leq 1 \times 10^{-5}$.

3.5 UNCERTAINTY ASSESSMENT

The assumptions included in each section of the assessment will be discussed, along with implications for over- or under-estimating risk.

4 REPORTING AND ADAPTIVE MANAGEMENT

The WSLRA and $HHRA_{country\ foods}$ for the Meadowbank Complex will evaluate risks to wildlife and consumers of country foods from contaminant exposure in and around the mine site every three years during operation. Results will be reported to NIRB in the context of Agnico Eagle’s Annual Report for the Meadowbank Complex.

Because of the conservative assumptions included at this level of assessment, there is generally considered to be a high degree of certainty associated with results indicating negligible risk (i.e. HQ <1 for the wildlife assessment, or <0.2 for the $HHRA_{county\ foods}$). When hazard quotients exceed these targets and measured concentrations in environmental media differ substantially between mine-related and external reference sites for an individual COPC, incremental risk due to mine operation will be classified as potentially unacceptable and more detailed investigations will be initiated. This may include a desk-top review and refining of the assessment parameters, and/or additional sampling in the subsequent year to confirm results. In the case that results of refined assessments continue to indicate unacceptable risk, adaptive management may include such interventions as capping of dust sources, increased road watering, delineation of contaminated areas, and deterrence methods pending reclamation.

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Appendix A

Toxicity Reference Values, Bio-Transfer Factors, and Tolerable Daily Intake Values, as used in previous assessments.

(To be updated using current literature, as available, at the time of future assessments)

Table A-1: WSLRA Toxicity Reference Values (mg/kg d) (as updated in the 2021 assessment)

Parameter	Receptor	TRV Basis	Antimony[2,3,4]	Arsenic[1]	Barium[1]	Beryllium[1,2]	Cadmium[1]	Chromium[1,5]	Cobalt[7]	Copper[1]	Lead[1]	Manganese[1]	Total Hg	Inorg-Hg[1]
Mammals	Northern Red-backed Vole	NOAEL	98.0	0.126	5.1	0.66	1	3.3	0.2	11.7	8	88	na	1
		LOAEL	112.9	1.26	19.8	na	10	13.1	2	15.1	80	284	na	na
	Caribou	NOAEL	98.0	0.126	5.1	0.66	1	3.3	0.2	11.7	8	88	na	1
		LOAEL	112.9	1.26	19.8	na	10	13.1	2	15.1	80	284	na	na
Birds	Lapland Longspur	NOAEL	9.8	2.5	21	0.066	1.5	1	2.37	47	1.1	977	na	0.45
		LOAEL	11.3	7.4	42	na	20	5	4.74	62	11.3	na	na	0.9
	Canada Goose	NOAEL	9.8	2.5	21	0.066	1.5	1	2.37	47	1.1	977	na	0.45
		LOAEL	11.3	7.4	42	na	20	5	4.74	62	11.3	na	na	0.9
	Semi-palmated Sandpiper	NOAEL	9.8	2.5	21	0.066	1.5	1	2.37	47	1.1	977	na	0.45
		LOAEL	11.3	7.4	42	na	20	5	4.74	62	11.3	na	na	0.9

Parameter	Receptor	TRV Basis	MeHg[1]	Molybdenum[1]	Nickel[1]	Selenium[1]	Strontium[1,2]	Thallium[1,6]	Tin[1]	Uranium[1]	Vanadium[1]	Zinc[1]	CN[8]
Mammals	Northern Red-backed Vole	NOAEL	0.015	0.26	40	0.2	263	0.0074	23.4	3.1	0.2	160	68.7
		LOAEL	0.025	2.6	80	0.3	na	0.074	35	6.1	2.1	320	na
	Caribou	NOAEL	0.015	0.26	40	0.2	263	0.0074	23.4	3.1	0.2	160	68.7
		LOAEL	0.025	2.6	80	0.3	na	0.074	35	6.1	2.1	320	na
Birds	Lapland Longspur	NOAEL	0.0064	3.5	77.4	0.4	26.3	0.202	6.8	16	11.4	14.5	0.025
		LOAEL	0.064	35.3	107	0.8	na	0.757	16.9	na	na	131	na
	Canada Goose	NOAEL	0.0064	3.5	77.4	0.4	26.3	0.202	6.8	16	11.4	14.5	0.025
		LOAEL	0.064	35.3	107	0.8	na	0.757	16.9	na	na	131	na
	Semi-palmated Sandpiper	NOAEL	0.0064	3.5	77.4	0.4	26.3	0.202	6.8	16	11.4	14.5	0.025
		LOAEL	0.064	35.3	107	0.8	na	0.757	16.9	na	na	131	na

Notes:

No allometric scaling for mammals (or birds) per Golder, 2019b

underline corresponds to an unbounded LOAEL (10X safety factor used to derive the NOAEL) (see text for details)

na indicates that there was no TRV (NOAEL or LOAEL) available

[1] Sample et al. (1996)

[2] Bird TRVs calculated by multiplying the mammal TRVs with a safety factor of 0.1 (see text for discussion)

[3] NOAEL from Dieter et al. (1991) as quoted in Lynch et al. (1999)

[4] LOAEL from Rossi et al. (1987)

[5] Mammals TRV based on chromium VI; bird TRV based on chromium III

[6] Ueberschar et al. (1986)

[7] Chetty et al. (1979) for mammal NOAEL TRV, Szakmary et al. (2001) for mammal LOAEL TRV, Van Vleet (1982) for bird TRVs.

[8] Bird TRV from Ma and Pritsos (1997) in Golder (2004); uncertainty factor of 10 was applied to account for chronic exposure.

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Table A-2: HHRA$_{country\ foods}$ biotransfer factors used in 2011, 2014, and 2017 assessments.

COPC	Caribou				Canada Goose	
	Feed-to-Muscle		Muscle-to-Kidney[1]	Muscle-to-Liver[1]	Feed-to-Muscle	
	d/kg	Source[2]			d/kg	Source[3]
Antimony	0.0012	IAEA 2010	1.17	0.82	0.006	Staven et al. 2003
Arsenic	0.002	USEPA 2005	6.45	0.64	0.83	Staven et al. 2003
Barium	0.00014	IAEA 2010	40.9	2.66	0.019	IAEA 2010
Beryllium	0.001	USEPA 2005	2.33	0.87	0.4	Staven et al. 2003
Cadmium	0.0058	IAEA 2010	2049	287	1.75	IAEA 2010
Chromium	0.0055	USEPA 2005	0.52	0.78	0.8	Staven et al. 2003
Cobalt	0.00043	IAEA 2010	10.5	18.6	0.97	IAEA 2010
Copper	0.01	RAIS 2012	2.06	13.7	0.5	Staven et al. 2003
Lead	0.0007	IAEA 2010	33.2	250	0.8	IAEA 2010
Manganese	0.0005	IAEA 2010	0.85	0.68	0.05	IAEA 2010
Inorg-Hg	0.00609	NCRP 1989	105	15	0.03	IAEA 2010
MeHg	0.00078	USEPA 2005	105	15	0.03	Staven et al. 2003
Molybdenum	0.001	IAEA 2010	44.2	153	0.18	IAEA 2010
Nickel	0.006	USEPA 2005	1.68	1.21	0.001	Staven et al. 2003
Selenium	0.32	IAEA 2010	19.3	2.28	9.7	IAEA 2010
Strontium	0.008	IAEA 2010	5.27	1.28	0.08	Staven et al. 2003
Thallium	0.04	USEPA 2005	14.9	2.51	0.8	Staven et al. 2003
Tin	0.001	RAIS 2012	3.88	9.44	0.8	IAEA 2010
Uranium	0.00039	IAEA 2010	3.23	2.61	0.75	IAEA 2010
Vanadium	0.0025	RAIS 2012	4.33	5.85	2	Staven et al. 2003
Zinc	0.16	IAEA 2010	0.95	1.11	0.47	IAEA 2010

Notes:

1 - All muscle-to-organ factors were obtained from Gamberg (2012)

2 - For Caribou feed-to-muscle factors, all values are for beef, with the exception of selenium, which is for pig.

3 - All values for Canada Goose are for chicken

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Table A-3: HHRA$_{country\ foods}$ tolerable daily intake (TDI) values used in the baseline (2005) assessment and subsequent updates (2011, 2014, 2017).

<table>
<tr><th rowspan="2">COPC</th><th colspan="3">TDI (µg/kg·day)</th><th colspan="3">Source</th></tr>
<tr><th>2005</th><th>2011</th><th>2014 & 2017</th><th>2005</th><th>2011</th><th>2014 & 2017</th></tr>
<tr><td>Antimony</td><td>0.4</td><td>0.4</td><td>0.4</td><td colspan="3">IRIS[1]</td></tr>
<tr><td>Arsenic</td><td>2</td><td>0.3</td><td>0.3</td><td>HC 2002</td><td colspan="2">IRIS[1]</td></tr>
<tr><td>Barium</td><td>200</td><td>200</td><td>200</td><td colspan="2">IRIS[1]</td><td>HC 2010</td></tr>
<tr><td>Beryllium</td><td>2</td><td>2</td><td>2</td><td colspan="3">IRIS[1]</td></tr>
<tr><td>Cadmium</td><td>1</td><td>0.8</td><td>1*</td><td colspan="2">HC 2004</td><td>HC 2010</td></tr>
<tr><td>Chromium</td><td>5.4</td><td>1</td><td>1</td><td>HC 1996</td><td>HC 2004</td><td>HC 2010</td></tr>
<tr><td>Cobalt</td><td>1.4</td><td>1.4</td><td>1.4</td><td colspan="3">RIVM 2001</td></tr>
<tr><td>Copper</td><td>250</td><td>30</td><td>91#</td><td>HC 2002</td><td>HC 2004</td><td>HC 2010</td></tr>
<tr><td>Lead</td><td>3.6</td><td>3.6</td><td>0.1+</td><td colspan="2">HC 2004</td><td>HC 2014</td></tr>
<tr><td>Manganese</td><td>140</td><td>-</td><td>136#</td><td colspan="2">IRIS[1]</td><td>HC 2010</td></tr>
<tr><td>Inorg-Hg</td><td>0.71</td><td>0.3</td><td>0.3</td><td>HC 2002</td><td>HC 2004</td><td>HC 2010</td></tr>
<tr><td>MeHg</td><td>0.2</td><td>0.1</td><td>0.2^</td><td>HC 2002</td><td>IRIS[1]</td><td>HC 2010</td></tr>
<tr><td>Molybdenum</td><td>5</td><td>5</td><td>23000#</td><td colspan="2">IRIS[1]</td><td>HC 2010</td></tr>
<tr><td>Nickel</td><td>17</td><td>17</td><td>20</td><td colspan="2">IM 2001</td><td>IRIS[1]</td></tr>
<tr><td>Selenium</td><td>5</td><td>5</td><td>6200#</td><td colspan="2">IRIS[1]</td><td>HC 2010</td></tr>
<tr><td>Strontium</td><td>600</td><td>-</td><td>600</td><td colspan="3">IRIS[1]</td></tr>
<tr><td>Thallium</td><td>0.07</td><td>0.07</td><td>0.01*</td><td colspan="2">IRIS[1]</td><td>USEPA 2012</td></tr>
<tr><td>Tin</td><td>-</td><td>200</td><td>300</td><td>-</td><td>ITER 2012</td><td>ATSDR 2005</td></tr>
<tr><td>Uranium</td><td>-</td><td>0.6</td><td>0.6</td><td>-</td><td>HC 2004</td><td>HC 2010</td></tr>
<tr><td>Vanadium</td><td>5</td><td>5</td><td>5</td><td colspan="3">IRIS[1]</td></tr>
<tr><td>Zinc</td><td>700</td><td>300</td><td>480#</td><td>HC 2002</td><td>IRIS[1]</td><td>HC 2010</td></tr>
</table>

Notes:

Inorganic arsenic was the only COPC identified as a potential carcinogen through the oral ingestion route, and the cancer slope factor was 1.80 (mg/kg·day)$^{-1}$ (Health Canada, 2010).

*provisional or screening value

#tolerable upper intake/essential trace element toxicity value (toddlers)

^value for women of child-bearing age and children <12 yrs

+median dietary lead exposure for the Canadian population

1 - IRIS database accessed in the assessment year - see References.

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