APPENDIX 25-A
2009 COUNTRY FOODS BASELINE REPORT

KSM PROJECT
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SEABRIDGE GOLD

Seabridge Gold Inc.

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Executive Summary

This report presents the country foods baseline assessment for the Seabridge Gold Inc. (Seabridge) proposed KSM (Kerr-Sulphurets-Mitchell) Project, conducted by Rescan Environmental Services Ltd. (Rescan). Country foods are animals, plants and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing or gathering of vegetation.

Seabridge is proposing the development of the KSM gold/copper project (the Project) located in northwestern British Columbia. The Project is approximately located 65 km northwest of Stewart, British Columbia and approximately 20 km southeast of Barrick Gold's former Eskay Creek Mine.

The KSM Project is proposed to be a 120,000 mtpd open pit operation with an approximately 30 to 35 year mine life. A conventional ore processing plant will produce a copper/gold/silver concentrate, which will be transported by truck to the Port of Stewart for offshore shipment.

The information contained in this baseline assessment is intended to support the Environmental Assessment Certificate Application. The purpose of the assessment was to evaluate the baseline quality of country foods harvested from the study area. The methodology for the country foods baseline assessment was based on Health Canada's guidelines for assessing food issues in environmental impact assessments.

The country foods evaluated were moose (*Alces alces*), snowshoe hare (*Lepus americanus*), grouse (*Phasianidae* sp.) and highbush cranberry (*Viburnum edule*). Fish species were not included in the country foods baseline assessment because all freshwater fish collected from the study area were too small for human consumption. Salmon species were not evaluated because they are anadromous and reside primarily in marine waters except during early juvenile life stages and spawning migrations. The quality of adult salmon that may be harvested from the study area would reflect their long-term exposure to marine environments, rather than the short-term exposure to freshwater environments during their spawning migration. Adult salmon do not eat during their migration, further limiting their exposure to the freshwater environment.

The country foods baseline assessment focused on metals because the Project is a proposed metal mine. Seven metals were selected for evaluation in this assessment. Metals were selected based on screening of the soil and surface water baseline data collected from the study area against the Canadian Council of Ministers of the Environment guidelines. The metals evaluated were aluminum, arsenic, cadmium, copper, lead, selenium and zinc. Metal concentrations in foods were modelled for moose, snowshoe hare and grouse muscle tissue, while the berries of ripened highbush cranberry were collected for laboratory analysis.

The results of this baseline assessment indicated that unacceptable risks are not present to human receptors from the consumption of moose, snowshoe hare, grouse and highbush cranberry that may harvested from the study area. Country food harvesters can continue to consume these foods at the rates and frequencies assumed in this assessment.

Table of Contents

List of Figures

FIGURE **PAGE**

List of Tables

List of Appendices

List of Acronyms

95% UCLM	95% upper confidence limit of the mean
BTF	biotransfer factor
BW	body weight (kg)
CCME	Canadian Council of Ministers of the Environment
COPC	contaminant of potential concern
EDI	estimated daily intake (mg/kg BW/day)
ELDI	estimated lifetime daily intake (mg/kg BW/day)
ER	exposure ratio
F	frequency of consumption
FAO	Food and Agriculture Organization of the United Nations
ILCR	incremental lifetime cancer risk
IR	ingestion rate (kg/day)
IRIS	Integrated Risk Information System
JECFA	Joint FAO/WHO Expert Committee on Food Additives
KSM	Kerr-Sulphurets-Mitchell
LOAEL	lowest observable adverse effects level
mtpd	Metric tonnes per day
NOAEL	no observed adverse effects
Rescan	Rescan Environmental Services Ltd. (environmental consultant)
RfD	reference dose
RMWI	recommended maximum weekly intake (kg/week)
Seabridge	Seabridge Gold Inc. (proponent)
TDI	tolerable daily intake (mg/kg BW/day)
the Project	the KSM Project
TRV	toxicity reference value

1. Introduction

1.1 PROJECT PROPONENT

The proponent for the KSM (Kerr-Sulphurets-Mitchell) Project is Seabridge Gold Inc. (Seabridge), a publicly traded junior gold company with common shares trading on the Toronto Stock Exchange in Canada and on the American Stock Exchange in the United States.

1.2 KSM PROJECT LOCATION

The KSM Project is a gold/copper project located in the mountainous terrain of northwestern British Columbia, approximately 950 km northwest of Vancouver, British Columbia, and approximately 65 km northwest of Stewart, British Columbia (Figure 1.2-1). The proposed Project lies approximately 20 km southeast of Barrick Gold's recently-closed Eskay Creek Mine and 30 km northeast of the Alaska border. The proposed processing plant and tailing management facility will be located about 15 km southwest of the community of Bell II on Highway 37.

The north and west parts of the Project area drain towards the Unuk River, which crosses into Alaska and enters the Pacific Ocean at Burroughs Bay. The eastern part of the Project area drains towards the Bell-Irving River, which joins the Nass River and empties into the Canadian waters of Portland Inlet. Elevations in the Project area range from under 240 m at the confluence of Sulphurets Creek with the Unuk River, to over 2,300 m at the nearby peak of the Unuk Finger.

1.3 KSM PROJECT DESCRIPTION

The KSM Project is a large proposed gold-copper mining project. Reserve figures released in a preliminary feasibility study announced on March 31, 2010 include 1.6 billion tonnes of ore containing 30.2 million ounces of gold, 7 billion pounds of copper, 133 million ounces of silver and 210 million pounds of molybdenum in the proven and probable categories. This environmental baseline study was designed to address a wide range of alternatives that have been assessed from engineering and cost perspective at various times during the baseline studies. The following project description is the base case for the March 2010 Preliminary Feasibility Study. Maps in subsequent sections of this baseline report may depict slightly different footprint configurations relating to earlier designs that prevailed at the time the fieldwork was completed.

The proposed Project as defined for the purposes of this environmental baseline study will be comprised of two distinct and geographically separate areas (the mining area and processing plant and tailing management area), shown in Figure 1.3-1. The proposed mining area is located in the drainage basin of Sulphurets Creek, a major tributary of the Unuk River. The proposed location of the processing plant and tailing management facility is in the headwaters of tributaries of Teigen and Treaty Creeks, which flow to the Bell-Irving River. The two areas will be connected by a pair of parallel tunnels. An overview of these proposed mine components is provided in the following two Sections.

1.3.1 Mining Area

It is proposed that the mining area will be accessed by a new road to be constructed from the current Eskay Creek mine road. The access road will be used to transport personnel, heavy mining equipment, mining supplies, and explosives. This new road will trend southwestwards to the headwaters of Coulter Creek and then follow the general course of Coulter Creek to the Unuk River. After crossing the Unuk

FIGURE 1.2-1

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KSM Project Location

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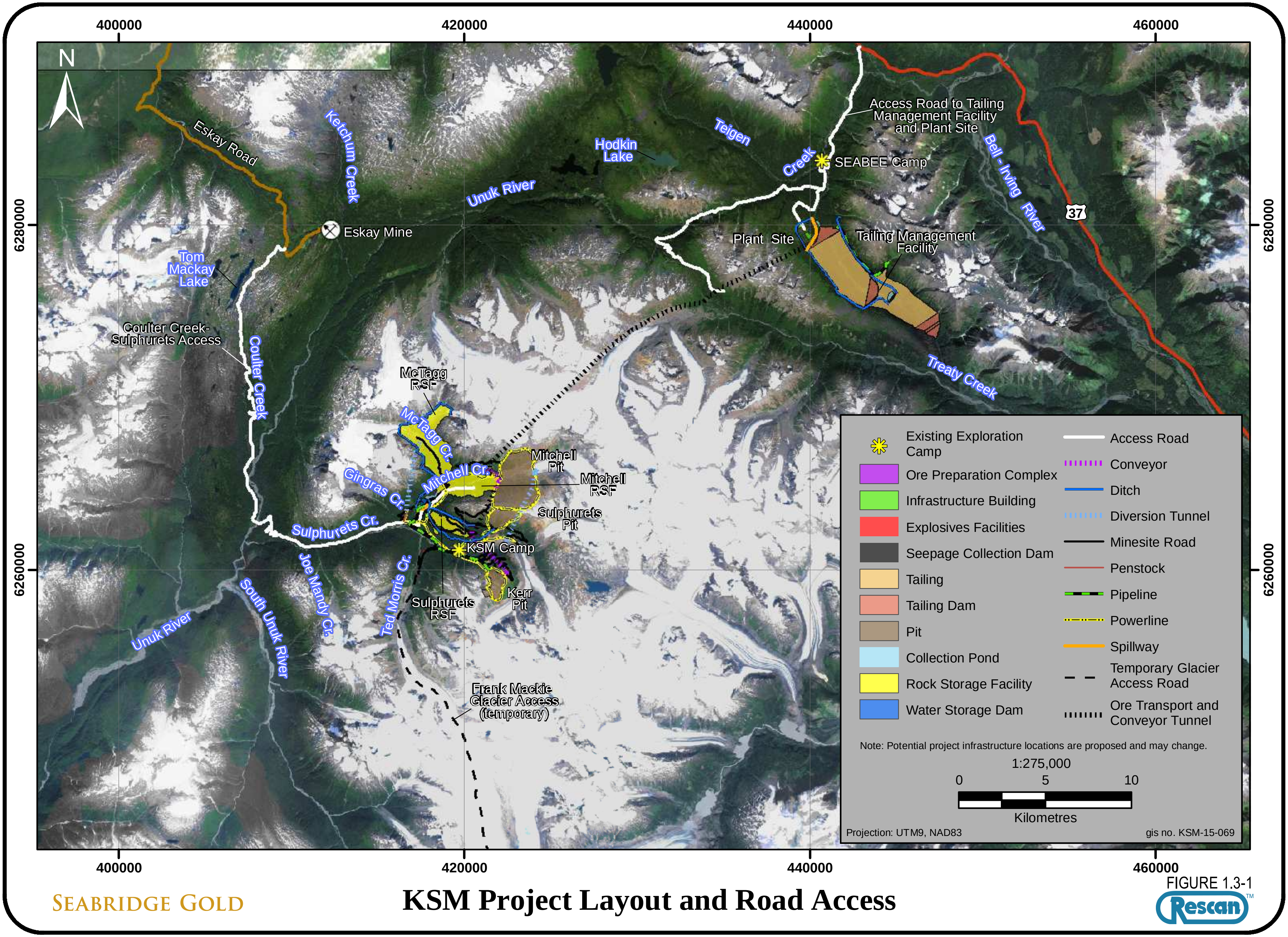

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FIGURE 1.3-1

KSM Project Layout and Road Access

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River it will follow the north side of the Sulphurets Creek Valley and cross Mitchell Creek. The Unuk River is considered navigable water under the *Navigable Waters Protection Act*. Branch roads will lead to each of the Kerr, Sulphurets and Mitchell deposits. Another branch road will head south parallel to Ted Morris Creek towards the toe of the north flowing tongue of Frank Mackie Glacier to provide access to the explosives manufacturing plant and related explosives magazines.

The support facilities for the mining area are proposed in the vicinity of the confluence of Sulphurets and Mitchell creeks. They will include accommodation for mine employees and administration and maintenance facilities.

The ore deposits will be bulk mined with large shovels and trucks and will use conventional drilling and blasting methods. The Kerr deposit is located on a ridge south of Sulphurets Lake. It is proposed that ore and non-ore mined rock will be transported from the Kerr deposit by conveyor to a tunnel portal (Sulphurets Mitchell tunnel) on the north side of Sulphurets Creek. These materials will be transported through the tunnel by conveyor to the Mitchell Creek Valley where they will be transported to the ore preparation complex or the Mitchell-McTagg rock storage facilities, respectively.

The Sulphurets deposit is located on the south side of the ridge north of Sulphurets Lake. It is proposed that ore will be transported by truck to the Sulphurets Mitchell tunnel and then by conveyor to the ore preparation complex. Non-ore mined rock will be transported to the Sulphurets rock storage facility on the south side of the ridge between the Mitchell Creek and Sulphurets Creek valleys, or to the Mitchell-McTagg rock storage facilities.

The Mitchell deposit straddles the Mitchell Creek Valley in an area recently exposed by the recession of the Mitchell Glacier. Mining of the deposit is proposed on both sides of the valley and to a depth of over 400 m below the current valley bottom. Seabridge proposes to construct a diversion tunnel from near the toe of the Mitchell Glacier, southwards towards the Sulphurets Creek Valley upstream of Sulphurets Lake to divert the flow of Mitchell Creek away from the proposed open pit area. It is proposed that the significant hydraulic head created by this tunnel will be used to drive a hydro-electric plant to generate a small portion of the electricity requirements of the Project.

Large volumes of low grade or barren rock will be removed in order to access the ore in each of the deposits. Non-ore rock removed to access ore will consist of both potentially acid generating (PAG) and not potentially acid generating (not PAG) rock. Rock storage areas have been defined in the Mitchell Creek and McTagg Creek valleys and on the south-facing side of the ridge between Sulphurets Creek and Mitchell Creek valleys. Runoff and seepage from the rock storage areas will be collected in a water storage facility contained behind a dam, to be located in the lower reaches of Mitchell Creek, and treated prior to discharge to the environment. The piped flow from the storage facility to the water treatment plant may be used to drive a hydro-electric plant.

A second diversion tunnel is proposed to direct the flow of McTagg Creek to the Sulphurets Creek Valley, thus avoiding the rock storage areas. The discharge from this tunnel will be available to drive a hydro-electric plant.

A run-of-river hydro-electric plant is proposed to harness the hydraulic head of the cascade in the lower reaches of Sulphurets Creek.

Ore from the deposits will be transported to an ore preparation complex, consisting of crushing and grinding facilities and related ore storage stockpiles, located on the north side of the Mitchell Creek Valley west of the Mitchell pit. Prepared ore will be mixed with water and pumped through one of two parallel 23 km-long tunnels to the process plant, proposed to be located in the drainage of a north-flowing tributary of Teigen Creek. The tunnels will daylight for a short distance near the divide between the Unuk River drainage and Treaty Creek before proceeding to the plant site in the Teigen Creek drainage. They will accommodate two pipelines to transport ore slurry as well as a return water pipeline, a diesel fuel pipeline, and a transmission line. The tunnels will slope towards Mitchell Creek so that all drainage can be controlled at the mine site and treated as necessary prior to release to the environment.

1.3.2 Processing and Tailing Management Area

The tunnel from the Mitchell Creek Valley will terminate on the south side of the valley formed by a north flowing tributary of Teigen Creek (South Teigen Creek) and a south flowing tributary of Treaty Creek (North Treaty Creek Tributary), adjacent to the plant site.

The plant will use a conventional grinding and flotation flowsheet to produce separate copper/gold and molybdenum concentrates, gold doré and tailing. It will process up to 120,000 tonnes per day of ore to produce an average of 1,200 tonnes per day of concentrate. The concentrate will be dried and transported to the port of Stewart by truck. It is anticipated that approximately 20 to 30 round trips per day will be required using 40 tonne payload trucks.

Vehicle access to the plant site will be by a 14 km long road along Teigen Creek from Highway 37. This road will require bridges to cross Teigen creek, which may be considered to be navigable water, and smaller tributaries.

The tailing will be pumped through pipelines to the tailing management facility located in the upper reaches of the Teigen Creek Valley, extending southeast over the divide into a tributary of the Treaty Creek drainage. The facility will be constructed in two phases: the north cell will be developed between a north dam, to be located across the valley of the south tributary of Teigen Creek near the plant site, and a south dam, to be located near the crest of the valley floor; and a south cell that will be retained by a southeast dam, to be located in the headwaters of the north tributary of Treaty Creek. The proposed facility will have storage capacity for the life of the Project within an area about 8 km long and 1.5 km wide. Seepage from the south and southeast dams will be pumped back into the impoundment to reduce any potential impact on the Treaty Creek drainage. Water diversion channels will be constructed on both flanks of the impoundment, where feasible, to divert clean water away from the impoundment. Supernatant water will be recovered from the impoundment using barge mounted pumps and recycled to the plant for process water. In the event that discharge is required, the excess water in the impoundment will be pumped over the northern dam towards the Teigen Creek drainage. Treatment of discharge water may be required to meet permit conditions.

It is assumed that electricity to power the plant and mine site will be obtained from the provincial electricity grid. A secondary transmission line will be constructed from a switching station, to be located near the point where Highway 37 crosses Snowbank Creek. The secondary line will follow the general alignment of the access road, to the plant site, and then pass through the tunnel to the mine site.

1.4 OVERVIEW

Country foods are animals, plants and fungi used by humans for nutritional or medicinal purposes that are harvested through hunting, fishing or gathering of vegetation. The quality of country foods is directly related to the quality of the surrounding environmental media (e.g., soil, water and vegetation). Since the Project is a metal mine, the quality of country foods is defined with respect to their metal concentrations.

This report presents a human health risk assessment from consuming country foods, harvested from the Project area. The assessment is based on baseline concentrations in country foods. In addition, the recommended maximum weekly intake (RMWI) of each country food is calculated following Health Canada's guidance on health impact assessments (Health Canada 2004a).

1.4.1 Background

There has been an increase in the concern over the quality of country foods within the past 15 years (INAC 2006). This concern is primarily due to studies showing concentrations of persistent organic pollutants and heavy metals in tissues of wildlife in undeveloped areas across northern Canada and the Arctic.

In response to these concerns, in 1991, Indian and Northern Affairs Canada developed the Northern Contaminants Program to determine the levels, geographic extent and source of contaminants in the north. More recently, research has included evaluating the health benefits and risks of consuming country foods. The potential benefits and risks have led Health Canada to provide guidance on the methodology of evaluating the quality of country foods (Health Canada 2004a). One of the main objectives of these studies is to provide information that assists individuals and communities in making informed decisions about their food consumption.

Persistent organic pollutants are human-generated chemicals whereas metals are naturally present in the water and soil. It is important to distinguish natural metal concentrations in the environment from anthropogenic inputs. Natural metal concentrations in water and soil vary, based on geography. In highly mineralized areas the water and soil can have naturally high concentrations of metals.

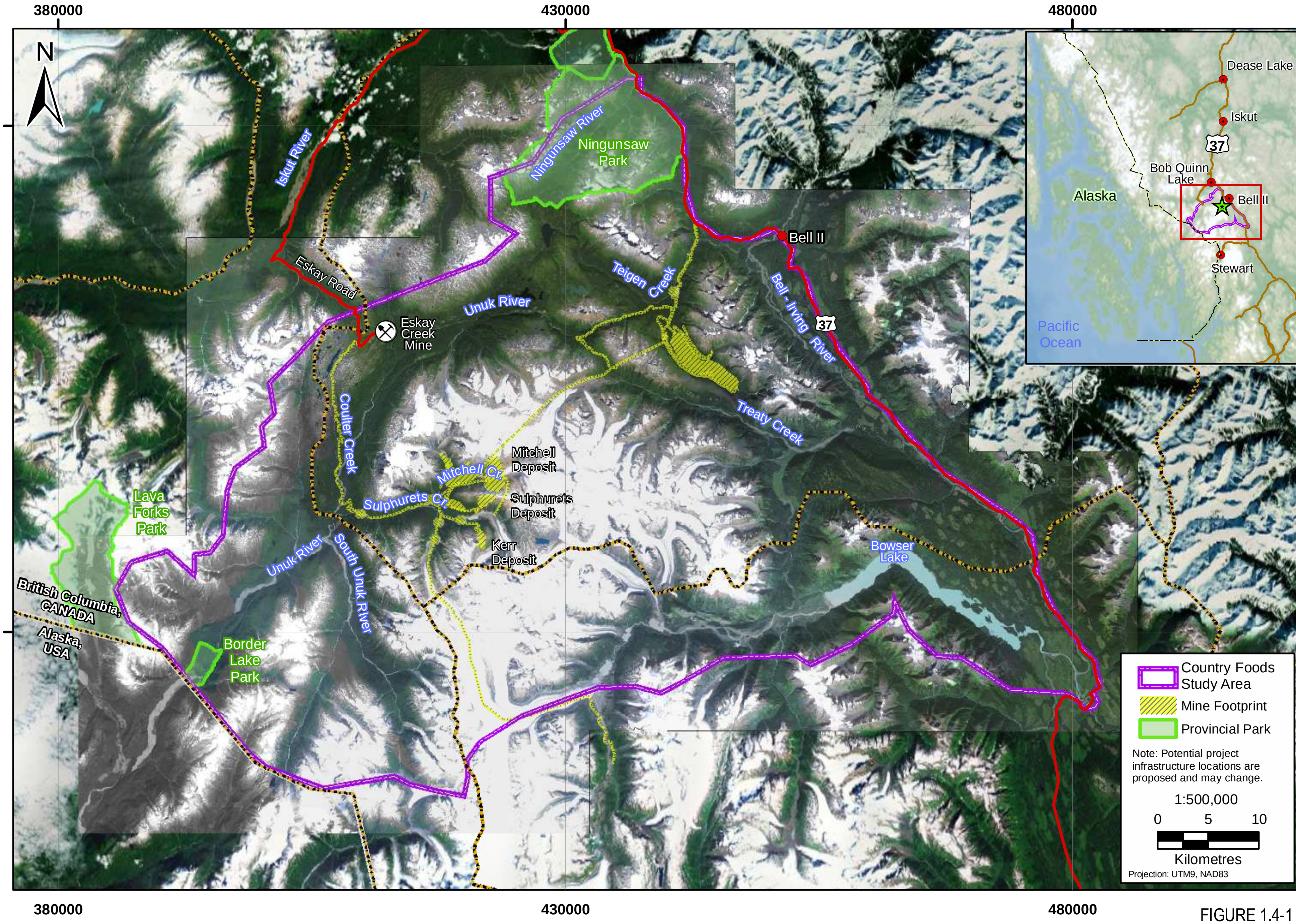
Many metals, such as copper and zinc, are essential minerals at low doses and are required to maintain proper health. However, extremely high doses of these metals can cause adverse health effects. Other metals such as cadmium and lead have no beneficial biological function. These positive health effects at low doses but may result in adverse health effects at high doses.

1.4.2 Study Area and Country Food Land Use

Figure 1.4-1 presents the study area for the country foods baseline assessment. The study area is based on the environmental baseline study areas for vegetation and wildlife (Rescan 2009 and 2010). These studies document the plant and animal species that exist within the study area.

Land use activities related to country foods include: guide outfitting, angling, trapping and potential berry picking. The study area falls within the boundaries of three guide outfitters, two anglers and seven trappers (Rescan 2009). The study area also overlaps with Border Lake (which is used for hunting, fishing and berry picking) and Ningunsaw Provincial Parks, which is used for fishing and berry picking (BC Parks 2009). Aboriginal groups who may use the study area for country food harvesting include the Nisg̱a'a Nation, Tahltan Nation, the Gitanyow *Wilp* Wii Litsque, Gitxsan *Wilp* Skii km Lax Ha and other Gitxsan *Wilp*.

Based on the land uses described above, this report focuses on First Nations, Nisg̱a'a Nation, guide outfitters, anglers, trappers and recreational land users (e.g., campers, fishers and hunters) as these are the people who likely consume country foods from the study area.



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KSM Country Food Baseline Study Area

FIGURE 1.4-1

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2. Methodology

The methodology for the country foods baseline assessment was based on Health Canada's guidelines for assessing food issues in environmental impact assessments (Health Canada 2004a).

The country foods baseline assessment was divided into the following five stages:

1. **Problem Formulation:** The conceptual model for conducting the country foods assessment was developed in the problem formulation stage. Metals were screened for their potential as contaminants of potential concern (COPC). Human receptor characteristics were also established in this stage.
2. **Exposure Assessment:** The measured or modelled COPC concentrations in country foods were integrated with human receptor characteristics to calculate the estimated daily intake (EDI) of each COPC.
3. **Effects Assessment (Toxicity Reference Value Assessment):** The toxicity reference values (TRVs) or tolerable daily intakes (TDIs) were identified for each COPC. The TRVs and TDIs are levels of daily exposure that can be taken into the body without appreciable health risk.
4. **Risk Characterization:** The exposure and effects assessments were integrated by comparing the EDIs with the TDIs to produce quantitative risk estimates, or exposure ratios (ER). In addition, the recommended maximum weekly intake (RMWI) of each country food was calculated.
5. **Uncertainty Analysis:** The assumptions made throughout the assessment and their effects on the conclusions were evaluated. Potential data gaps were identified and addressed.

3. Problem Formulation

3.1 INTRODUCTION

The purpose of the problem formulation stage is to create a conceptual model for the country foods baseline assessment. The conceptual model illustrates how metals that are naturally in the environmental media, such as soil and water, can transfer into biological tissue, such as plants and animals, and into humans through consumption. The objectives of the problem formulation stage are:

1. Identify the metals which are COPCs in the study area.
2. Identify the most relevant country food species harvested from the study area.
3. Identify the human receptors (i.e., people who consume country foods from the study area) and the relevant life stages (e.g., adults and toddlers).
4. Identify the human exposure pathways to COPCs.

3.2 COPCS SELECTED FOR EVALUATION

The proposed Project is a gold/copper mine, therefore, COPCs selected for the country foods assessment are metals. Metals are natural constituents of rocks, soil, water, air and sediments and are distributed in these environmental media through natural geological processes. All organisms are exposed to naturally occurring metal concentrations in their habitat. Some metals have been integrated into biological processes through evolution and serve as essential minerals while others have no beneficial biological function.

In highly mineralised areas, environmental media such as soils and water may have elevated metal concentrations under baseline conditions. In order to determine the appropriate metals to assess as COPCs, the baseline 95% upper confidence limit of the mean (95% UCLM) metal concentrations in the soil and water were screened against the Canadian Council of Ministers of the Environment (CCME) guidelines. The 95% UCLM encompasses the range of variability of detected concentrations, which is a reasonable representation of metal concentrations that animals are exposed to in the study area. Metals were selected as a COPC if they met one or more of the following criteria:

1. The 95% UCLM metal concentration from 100 surface soil samples (0 to 20 cm below the ground) from the soil baseline study exceeded the CCME guidelines for residential use (CCME 2007a, Rescan 2009 and Rescan 2010). Soil samples were collected at other depths, however these samples are less relevant to the country foods study as country food animals would typically not be exposed to them.
2. The 95% UCLM metal concentration from 325 surface water samples from the aquatics baseline studies exceeded the CCME water quality guidelines for the protection of aquatic life (CCME 2007b). The 95% UCLM was calculated based on samples collected between May 2008 and September 2009 (Rescan 2009 and Rescan 2010). The surface water data used in the country foods assessment is from samples collected within the study and does not include reference site data.
3. These guidelines were used only to select the COPCs for the country foods baseline assessment. They were not used to directly evaluate the baseline soil quality or water quality within the study area, as these evaluations are components of other baselines (i.e., the soils baseline and water quality baseline). The guidelines used to select the COPCs are the most stringent of the CCME environmental media guidelines.

Table 3.2-1 presents the metals that were selected as COPCs for the country foods baseline assessment and the rationale for their selection. The metals selected as COPCs were: aluminum, arsenic, cadmium, copper, lead, selenium and zinc.

Iron was not evaluated because of its essential nature and its relative lack of toxic effects compared with other metals. Iron is the second most abundant metal and the fourth most abundant element in the Earth's crust (BC MOE 2008; TOXNET 2009). Iron is ubiquitous in soils and sediment and usually exists in high concentrations relative to other metals. Most iron is tightly bound within the soil matrix and is not available for uptake into mammals or birds. Iron is an essential element and is a required component in blood cells and necessary for transporting oxygen in the body. Studies suggest that adverse effects related to high iron exposures are related to acute overdose of large quantities of iron supplements rather than dietary sources (Morris 2000). Iron was not evaluated because of its essential nature and its relative lack of toxic effects compared with other metals.

3.3 COUNTRY FOODS SELECTED FOR EVALUATION

Country foods can include a wide range of terrestrial wildlife, aquatic life and plants that are harvested for nutritional or medicinal use. Interviews with country food harvesters (i.e., trappers, guide outfitters and Aboriginal peoples) can provide the most detailed and accurate information with respect to country foods that are harvested from a particular area. However, if interviews cannot be conducted, desk-based literature research of contemporary land use can determine the country food species that are harvested and consumed. The following sections describe the attempts made to conduct country food interviews, the country foods selected, and the rationale for their selection.

3.3.1 Country Food Interviews

The purpose of country food interviews is to gather current information regarding country food consumption and harvesting habits of people who harvest from a particular area. The land use baseline study (Rescan 2009) identified three guide outfitters (Misty Mountain, Northwest Ranching and Coast Mountain Outfitters) and seven trapline licence areas which directly overlap parts of the study area. Starting in June 2009 through to September 2009, attempts were made to contact guide outfitters and trapline licence holders through telephone, voice mail and email (where available). Despite these attempts, country foods consumption interviews could not be arranged, due to a lack of response or lack of interest in participating in an interview. One respondent did indicate that several of the trapline licence holders had not been active in the area for at least two years.

Interviews with local Aboriginal residents who may harvest country foods from the study area have not taken place because consent has not (at the time of writing) been granted by the Aboriginal groups involved in the Project. Future country food interviews will take place to complement the existing study data pending the consent of the relevant Aboriginal groups involved.

Consequently, literature-based information was used in order to select the country foods for assessment, rather personal interviews. It is noted that personal interviews are preferred over literature research because consumption and harvesting habits may vary spatially and temporally between people of the same geographical region. Literature information for food consumption patterns of people may encompass a large geographic area or focus on specific groups of people rather than the area of interest. The use of literature information to represent the actual use of a study area for harvesting has a large degree of uncertainty whereas country food interviews with local country food harvesters provides the most accurate and current information regarding country food consumption habits in a specific area. Thus, once the interviews with the Aboriginal groups have taken place, this report will be amended to include the more relevant consumption information.

Table 3.2-1. Metal Concentration Comparison to Guidelines and Metal COPC Selection

Metals	Metal Included as COPC	Water 95% UCLM (mg/L)	CCME Guideline for the Protection of Aquatic Life (mg/L)	Soil 95% UCLM (mg/kg)	CCME Guideline for the Protection of Environmental and Human Health Parkland and Residential Use (mg/kg)
Aluminum	**Yes**	**2.74**	**0.10**	**26586**	**No guideline**
Antimony	No	0.0008	No guideline	7.484	No guideline
Arsenic	**Yes**	**0.01**	**0.005**	**37.44**	**0.12**
Barium	No	0.076	No guideline	172.4	500
Beryllium	No	0.00037	No guideline	0.682	No guideline
Bismuth	No	0.00027	No guideline	10.53	No guideline
Cadmium	**Yes**	**0.0014**	**0.000017**	**0.541**	**10**
Calcium	No	27	No guideline	3274	No guideline
Chromium	No	0.0033	0.0089	63.78	64
Cobalt	No	0.0031	No guideline	17.18	No guideline
Copper	**Yes**	**0.13**	**0.002**	**160.1**	**63**
Iron	**No***	**6.08**	**0.30**	**58506**	**No guideline**
Lead	**Yes**	**0.0041**	**0.002**	**27.31**	**140**
Lithium	No	0.003	No guideline	21.14	No guideline
Magnesium	No	4.5	No guideline	9206	No guideline
Manganese	No	0.2	No guideline	1081	No guideline
Mercury	No	0.000012	0.000026	0.264	6.6
Molybdenum	No	0.0018	0.073	13.35	No guideline
Nickel	No	0.004	0.065	44.29	50
Potassium	No	1.11	No guideline	1341	No guideline
Selenium	**Yes**	**0.0014**	**0.001**	**1.956**	**1**
Silver	No	0.000069	0.0001	1.442	No guideline
Sodium	No	1.3	No guideline	289.6	No guideline
Strontium	No	0.175	No guideline	35.92	No guideline
Thallium	No	0.00007	0.0008	0.25	1
Tin	No	0.00008	No guideline	3.798	No guideline
Titanium	No	0.12	No guideline	1031	No guideline
Uranium	No	0.00029	No guideline	Not analyzed	23
Vanadium	No	0.009	No guideline	108.2	130
Zinc	**Yes**	**0.1**	**0.03**	**94.57**	**200**

* = excluded as a COPC, see text for rationale.

3.3.2 Literature Research of Potential Country Food Species

The vegetation and wildlife baselines were reviewed in order to compile a list of edible vegetation and wildlife that has been recorded in the study area (Rescan 2009 and 2010). A complete list of all wildlife and vegetation recorded in the study area can be found in the respective baseline studies. A list of potential country food species in the study area is presented in Table 3.3-1.

Table 3.3-1. List of Potential Country Food Species

Category	Common Name	Species Name
Small Mammal	Beaver	*Castor canadensis*
	Snowshoe Hare	*Lepus americanus*
	Hoary Marmot	*Marmota caligata*
Large Mammal	Black Bear	*Ursus americanus*
	Deer	*Odocoileus hemionus sitkensis*
	Grizzly Bear	*Ursus arctos*
	Moose	*Alces alces*
	Mountain Goat	*Oreamnos americanus*
Birds	Canada Goose	*Branta canadensis*
	Common Loon	*Gavia spp.*
	Harlequin Duck	*Histrionicus histrionicus*
	Mallard	*Anas platyrhynchos*
	Ring-necked Duck	*Athya collaris*
	Rock ptarmigan	*Sterna paradisaea*
	Ruffed Grouse	*Bonasa umbellus*
	Sooty Grouse	*Dendragapus obscurus*
	Spruce Grouse	*Falcipennis canadensis*
	Trumpeter Swan	*Cygnus buccinator*
Fish	Bull Trout	*Salvelinus confluentus*
	Chinook Salmon	*Oncorhynchus tschawytscha*
	Coho Salmon	*Oncorhynchus kisutch*
	Cutthroat Trout	*Oncorhynchus clarki*
	Dolly Varden	*Salvelinus malma malma*
	Mountain Whitefish	*Prosopium williamsoni*
	Rainbow Trout / Steelhead	*Oncorhynchus mykiss*
Vegetation	Alaskan Blueberry	*Vaccinium alaskaense*
	Black Gooseberry	*Ribes lacustre*
	Black Huckleberry	*Vaccinium membranaceum*
	Bog Cranberry	*Oxycoccus oxycoccos*
	Bunchberry	*Cornus canadensis*
	Cow Parsnip	*Heracleum maximum*
	Crowberry	*Empetrum nigrum*
	Devil's Club	*Oplopanax horridus*
	Dwarf Blueberry	*Vaccinium caespitosum*
	Grouseberry	*Vaccinium scoparium*
	Highbush Cranberry	*Viburnum edule*
	Mountain Ash	*Sorbus spp.*
	Northern Blackcurrant	*Ribes hudsonianum*
	Oval-leaved Blueberry	*Vaccinium ovalifolium*
	Salmonberry	*Rubus spectabilis*
	Sub-Alpine Fir	*Abies lasiocarpa*
	Trailing Black Currant	*Ribes laxiflorum*
	Yarrow	*Achillea millefolium*

3.3.3 Selected Country Foods

One species from each country food category (i.e., small mammal, large mammal, bird and vegetation) was selected for evaluation. The small mammal, large mammal and bird country foods were selected based on the highest annual consumption quantity. In the absence of country food interviews, the annual consumption quantity was based consumption information available for the Tahltan First Nation from the study entitled "*Survey of traditional food and medicine consumption among Tahltan people in Dease Lake, Telegraph Creek and Iskut, BC, 2006-2006*" (Jin 2006). The food category method, based on the highest annual consumption quantity, was selected as it is not practical to assess every country food that could be harvested from the study area. If the country food consumed in the greatest quantity poses no health risk, other foods in the same category which are consumed less frequently would also pose no health risk. For the vegetation country food, blueberry was reported as being the highest consumed berry; however, blueberry was not identified as the most abundant country food within the study area. Highbush cranberry was identified as being more widespread and abundant throughout the study area, and thus, if people do harvest berries from this area, they are more likely to be harvesting highbush cranberry rather than blueberry. Consequently, highbush cranberry was selected for this assessment.

Fish were not included in the study because the fisheries baseline study only yielded small fish that were not large enough to eat (Rescan 2009 and 2010). Bull trout, Chinook salmon, Coho salmon, cutthroat trout and Dolly Varden, mountain whitefish and rainbow trout were collected from various water bodies within the study area. The largest of 298 fish collected in the study area, among all species, was a Dolly Varden weighing 115.7 grams and 22 cm fork length. These fish are considered too small for normal consumption.

Larger fish such as adult salmon are present in the streams and rivers in the study area. However, adult salmon are anadromous and spend the vast majority of their lifespan living in marine environments. COPCs that have accumulated in the tissues of adult salmon originate from exposures to marine waters and marine food. The time spent in freshwater environments during their migration is comparatively short. In addition, adult salmon do not feed during their migration into freshwater spawning grounds, further reducing their exposure to COPCs from the study area. Therefore, fish from the genus *Oncorhunchus* are not appropriate indicators of country food quality in the study area.

The country food species that were selected for evaluation include: moose, snowshoe hare, grouse and highbush cranberry.

3.4 HUMAN RECEPTORS

The human receptors considered are people who consume country foods as a substantial proportion of their total diet throughout the year. These people may include local or hunters, fishers, resident trappers, guide outfitters and Aboriginal peoples.

Both adults (older than 19 years of age) and toddlers (six months to four years) were evaluated for their susceptibility to metals exposure from the consumption of country foods. Toddlers are most susceptible to metals with threshold response levels (non-carcinogenic) because of their higher ingestion rate per unit of body weight and food absorption rates relative to other age groups (Health Canada 2004b). Toddlers (and the elderly) also experience life-stage sensitivity and would be at a greater potential risk compared to adults.

For non-threshold (carcinogenic) metals, both adult and toddlers are susceptible. The effects from exposure to carcinogenic metals are cumulative over the lifespan of a person, and cancers generally develop later in life. Therefore, carcinogenic effects are assessed from the estimated daily exposure to the carcinogenic metals over the average lifespan of a person (80 years), rather than a toddler (Health Canada 2004b). Based on the metals selected as COPCs, arsenic was the only COPC that is considered carcinogenic, via the ingestion pathway.

3.5 HUMAN EXPOSURE PATHWAYS

Human exposure pathways are the routes by which people are exposed to chemicals. Food-related exposure pathways were selected for the country foods assessment based on the ingestion of:

- terrestrial animals (i.e., moose, snowshoe hare and grouse) that have taken up metals through the ingestion of surface water, vegetation and soils; and
- plants (i.e., highbush cranberry) that have taken up metals from the soil and water.

The human exposure pathways are presented in Figure 3.5-1. This figure presents the sources of the metals (i.e., soil and water), residency media (e.g., vegetation and terrestrial animals), and exposure routes to human receptors. The conceptual model for this assessment is presented in Figure 3.5-2, which describes how metals in the environment move into the food chain and subsequently into humans through their diet.

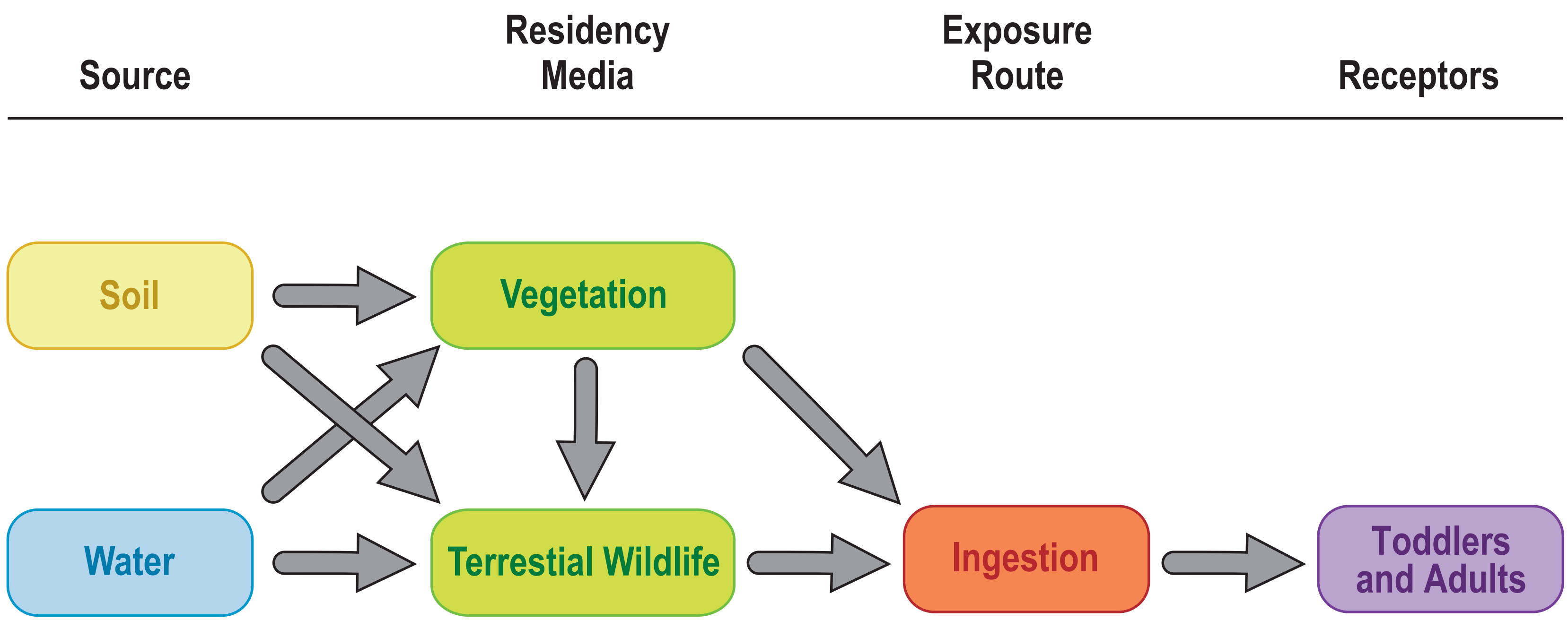

FIGURE 3.5-1

Human Exposure Pathways

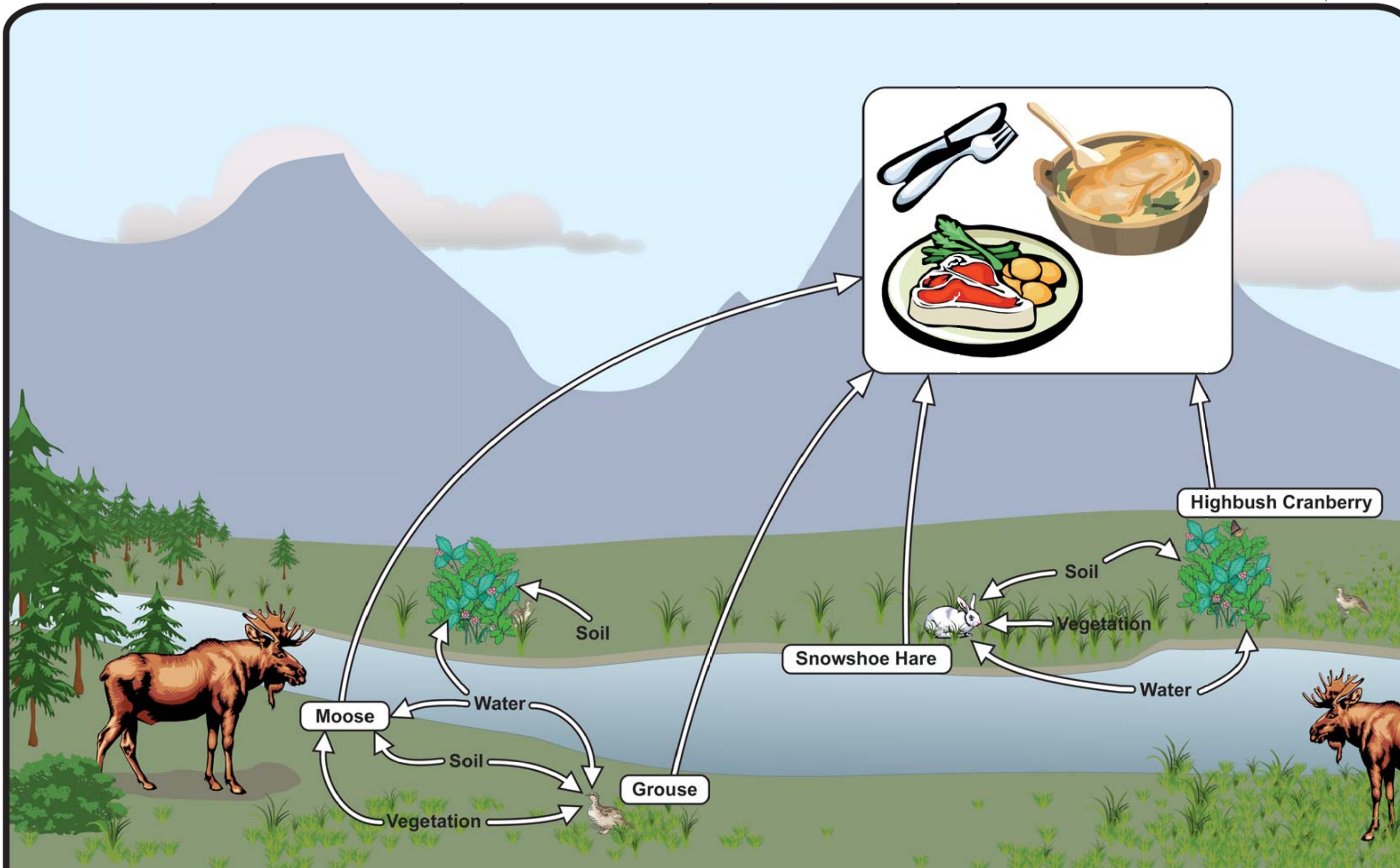

FIGURE 3.5-2

SEABRIDGE GOLD

Country Foods Conceptual Model of COPC Exposure

Rescan™

4. Exposure Assessment

4.1 INTRODUCTION

For the exposure assessment the estimated daily intake (EDI) of metals that human receptors would be exposed to through the consumption of country foods, was calculated. The amount of metals that human receptors are exposed to from consuming country foods depends on the following factors:

- the concentration of metals in animals resulting from their ingestion of environmental media (e.g., vegetation, water, and soil);
- the concentration of metals in vegetation resulting from their uptake of metals from environmental media (e.g., soil and water); and
- human receptor characteristics (e.g., consumption amount, frequency, body weight).

The following section presents EDI values for each receptor and COPC.

4.2 ESTIMATED DAILY INTAKE

The following equation was used to estimate the EDI of COPCs from the consumption of country foods:

$$EDI_{food} = \frac{IR \times C_{food} \times F}{BW}$$

Where:
EDI_{food} = estimated daily intake of COPCs from country food (mg/kg BW/day)
IR = ingestion rate (kg/day)
C_{food} = concentration of COPCs in food (mg/kg)
F = exposure frequency - # days exposed to food per 365 days (unitless)
BW = body weight (kg BW)

The following section describes the input parameters used to calculate the EDI.

4.2.1 Country Food Metal Concentrations

In August 2009, Rescan asked the Misty Mountain guide outfitter if he would be willing to collect tissue samples from moose harvested during the hunting season. However, the guide outfitter informed Rescan that he would not be in the study area during the moose hunting season and therefore, would not be guiding moose hunts. Local Aboriginal groups were not asked for moose samples harvested from the study area due to pending consent of the Aboriginal groups to participate in the assessment. Consequently, no moose tissue samples were collected from the study area for metal analysis.

Moose, snowshoe hare and grouse tissue concentrations were estimated using a food chain model, presented in Appendix 1. The food chain model predicts the concentration of metals in animal tissue based on the 95% UCLM metal concentrations in the water, soil, and vegetation which they consume. The model also incorporates the consumption rates of these media for each animal. Table 4.3-1 presents the predicted tissue concentrations in moose (C_{moose}), snowshoe hare (C_{hare}) and grouse (C_{grouse}).

Attempts were made in August of 2008 and September of 2009 during the typical ripening months to collect the fruits of the highbush cranberry. In 2008, berries were not ripe when the collection attempt was made. In 2009, three samples were collected and analyzed for metal concentrations. The analytical data from the sampling are presented in Appendix 2. Table 4.2-1 presents the maximum concentration of metals detected in highbush cranberry (C_{berry}). The maximum is used because the sample size is too low to calculate the 95% UCLM.

Table 4.2-1. Metal Concentrations in Country Foods (mg/kg)

Metal	C_{moose}	C_{hare}	C_{grouse}	C_{berry}
Aluminum	6.40×10^{0}	2.17×10^{-1}	2.29×10^{1}	8.50×10^{0}
Arsenic	1.20×10^{-2}	3.97×10^{-4}	3.26×10^{-2}	5.00×10^{-3}
Cadmium	6.54×10^{-4}	3.23×10^{-5}	1.09×10^{-2}	2.50×10^{-3}
Copper	3.55×10^{-1}	1.33×10^{-2}	1.37×10^{-1}	9.31×10^{-1}
Lead	1.75×10^{-3}	5.89×10^{-5}	2.33×10^{-2}	1.00×10^{-2}
Selenium	1.83×10^{-1}	8.69×10^{-3}	1.34×10^{-1}	1.00×10^{-1}
Zinc	1.11×10^{1}	5.33×10^{-1}	6.37×10^{0}	1.53×10^{0}

4.2.2 Human Receptor Characteristics

Receptor characteristics were based on guidance provided by Health Canada (2004b) and country foods interviews conducted by Jin (2006, unpublished). The ingestion rate and frequency of each country food was assumed to accurately represent the consumption pattern of people who consume the most of each country food from the study area (Table 4.2-2). Data from the Jin (2006, unpublished) interviews were based on adult serving size and consumption frequency. It was assumed that a toddler would eat the country foods at the same frequency as adults. The assumed toddler serving sizes were calculated as 43% of the adult serving size as per Richardson (1997). It is anticipated that this assumption overestimates the actual toddler serving sizes. The receptor characteristics assumed are presented in Table 4.5-1.

Table 4.2-2. Human Receptor Characteristics

Body Weight (BW)	Toddlers 16.5 kg			Adults 70.7kg		
Country Food	**Ingestion Rate (IR) (kg/day)**	**# Meals per Year**	**Exposure Frequency (F)**	**Ingestion Rate (IR) (kg/day)**	**# Meals per Year**	**Exposure Frequency (F)**
Moose	0.0916	364	0.9973	0.213	364	0.9973
Snowshow Hare	0.1496	3	0.0082	0.348	3	0.0082
Grouse	0.1286	6	0.0164	0.299	6	0.0164
Highbush cranberry	0.1204	12	0.0329	0.280	12	0.0329

4.3 RESULTS

The EDI of COPCs from each country food for toddlers and adults are presented in Table 4.3-1. For this assessment, it was assumed that 100% of the country foods consumed by a person are harvested from the study area and that 100% of the metals are bioavailable and absorbed into the body. Appendix 3 presents a sample calculation of the EDI for selenium for toddlers consuming moose muscle tissue.

Table 4.3-1. Estimated Daily Intake of COPCs (mg/kg BW/day)

	Moose EDI		Snowshoe Hare EDI		Grouse EDI		Berry EDI	
Metals	**Toddler**	**Adult**	**Toddler**	**Adult**	**Toddler**	**Adult**	**Toddler**	**Adult**
Aluminum	3.54×10^{-02}	1.92×10^{-02}	1.61×10^{-05}	8.76×10^{-06}	2.92×10^{-03}	1.59×10^{-03}	1.95×10^{-03}	1.06×10^{-03}
Arsenic	2.66×10^{-05}	1.44×10^{-05}	1.18×10^{-08}	6.40×10^{-09}	1.67×10^{-06}	9.06×10^{-07}	4.58×10^{-07}	2.48×10^{-07}
Cadmium	3.62×10^{-06}	1.97×10^{-06}	2.40×10^{-09}	1.30×10^{-09}	1.40×10^{-06}	7.58×10^{-07}	5.72×10^{-07}	3.11×10^{-07}
Copper	1.96×10^{-03}	1.07×10^{-03}	9.87×10^{-07}	5.36×10^{-07}	1.75×10^{-05}	9.48×10^{-06}	2.13×10^{-04}	1.16×10^{-04}
Lead	9.68×10^{-06}	5.26×10^{-06}	4.38×10^{-09}	2.38×10^{-09}	2.97×10^{-06}	1.61×10^{-06}	2.29×10^{-06}	1.24×10^{-06}
Selenium	1.01×10^{-03}	5.49×10^{-04}	6.46×10^{-07}	3.51×10^{-07}	1.71×10^{-05}	9.30×10^{-06}	2.29×10^{-05}	1.24×10^{-05}
Zinc	6.15×10^{-02}	3.34×10^{-02}	3.96×10^{-05}	2.15×10^{-05}	8.15×10^{-04}	4.42×10^{-04}	3.50×10^{-04}	1.90×10^{-04}

5. Toxicity Reference Value Assessment

5.1 INTRODUCTION

The toxicity reference value (TRV) assessment involves determining the amount of COPCs that can be taken into the human body without experiencing adverse health effects. TRVs are safe levels below which there is minimal risk of adverse health effects. The TRVs used in the country foods assessment were obtained from Health Canada (Health Canada 2006 and 2008, unpublished). The TRVs were derived by Health Canada's Bureau of Chemical Safety, Chemical Health Hazard Division or were adopted by Health Canada from various other regulatory agencies such as the US EPA's Integrated Risk Information System (IRIS), Food and Agriculture Organization of the United Nations, World Health Organization and the Joint Expert Committee on Food Additives (JECFA).

Toxicity information comes from human studies where health effects resulting from exposures to substances have been documented. Toxicity information also comes from animal studies, where animal dose-response information is extrapolated to humans by applying uncertainty factors typically ranging from 100 to 1,000. Therefore, TRVs based on animal studies generally have large uncertainty factors to ensure that the toxicity or risk of a substance to people is not underestimated.

The TRVs in this assessment are presented as Tolerable Daily Intakes (TDIs). The TDI is defined as the amount of metal per unit body weight that can be taken into the body each day with no risk of adverse health effects. The adverse health effects considered are threshold responses (non-carcinogenic).

For non-threshold (carcinogenic) response COPCs, oral slope factors are used for the estimation of cancer risk. The oral slope factor is the estimated probability of cancer development per unit intake of a chemical over a lifetime. The only COPC with carcinogenic effects via the ingestion pathway is arsenic.

The TDIs and oral slope factors used in this assessment are presented in Table 5.1-1. Toxicity studies from which these were based, and the rationale for their selection, are briefly summarized in Section 5.2.

Table 5.1-1. Toxicity Reference Values for Contaminants of Potential Concern

Metal	Tolerable Daily Intake (TDI) (mg/kg BW/day)	Oral Slope Factor $(mg/kg\ BW/day)^{-1}$
Aluminum	0.3	
Arsenic	0.001	0.03
Cadmium	0.001	
Copper	0.125	
Lead	0.00357	
Selenium	0.011	
Zinc	0.7	

5.2 TOXICITY REFERENCE VALUES

5.2.1 Aluminum

Health Canada (2008) provides a TDI of 0.3 mg/kg BW/day for aluminum. Health Canada does not provide a rationale for the derivation of this TDI.

5.2.2 Arsenic

For assessment of non-cancer risks from inorganic arsenic, Health Canada (2006) has presented a provisional TDI of 0.001 mg/kg BW/day for oral exposures to arsenic, based on recommendations by the JECFA. This value was used to estimate non-cancer risks from arsenic.

Arsenic is the only metal in this assessment that is considered carcinogenic via the ingestion pathway. Health Canada provides an oral slope factor for arsenic of 0.03 mg/kg BW/day^{-1}. Health Canada does not provide a rationale for the derivation of this slope factor.

5.2.3 Cadmium

Health Canada (2008) provides a TDI of 0.001 mg/kg BW/day for cadmium. This TDI is based on the World Health Organization's provisional tolerable weekly intake of 0.007 mg/kg BW/week *(*i.e., 0.001 mg/kg BW/day) (WHO, 2005). This provisional TDI will ensure cadmium concentrations in the renal cortex do not exceed 50 mg/kg, this level is thought to be protective of normal kidney function.

5.2.4 Copper

Health Canada (2008) provides a TDI of 0.125 mg/kg BW/day for copper. Health Canada does not provide a rationale for the derivation of this TDI.

5.2.5 Lead

Health Canada (2008) provides a TDI of 0.00357 mg/kg BW/day for lead. This TDI is based on the provisional tolerable weekly intake of 0.025 mg/kg BW/week recommended by the JECFA (JECFA 2000). JECFA concluded that this concentration of lead found in food would have negligible effects on the neurobehavioural development of infants and children.

5.2.6 Selenium

A TDI of 0.011 mg/kg BW/day is recommended by the Health Canada (2008). Health Canada does not provide a rationale for the derivation of this TDI.

5.2.7 Zinc

Health Canada (2008) provides a TDI of 0.7 mg/kg BW/day. This value is based on the upper safe level established by the Expert Group on Vitamins and Minerals (EVM, 2003). A lowest observable adverse effects level (LOAEL) of 50 mg/day was found for both men and women exposed to zinc supplements. The primary endpoint was a reduction of copper absorption by zinc, and subsequent reduced activity of the copper-dependent enzyme (erythrocyte superoxide dismutase). The LOAEL was converted to a no adverse effects level (NOAEL) by dividing it by an uncertainty factor of two to give a NOAEL of 25 mg/day, which is 0.42 mg/kg BW/day in a 60 kg person. Thus, the upper safety limit for zinc supplements is 0.42 mg/kg body weight/day. If the maximum zinc intake of 17 mg/day (0.28 mg/kg BW/day) from food is added to the upper safe level the maximum total intake for zinc is equivalent to 0.7 mg/kg BW/day.

6. Risk Characterization

6.1 INTRODUCTION

Using the results of the exposure assessment and toxicity reference value assessment, human health risks from the consumption of country foods were quantified. This chapter provides the methods and results of the estimates of human health risks. In addition, the recommended RMWIs are presented for each country food evaluated.

Health effects from chemicals are generally divided into two categories: threshold (i.e., non-carcinogenic) and non-threshold (i.e., carcinogenic) response chemicals. These two types of chemicals are evaluated differently. The following two sections describe the estimation of both non-carcinogenic and carcinogenic risk.

6.2 ESTIMATION OF NON-CARCINOGENIC RISK

Non-carcinogenic human health risk estimates were calculated based on the following formula:

$$\text{Exposure Ratio (ER)} = \frac{\text{Estimated Daily Intake (EDI)}}{\text{Tolerable Daily Intake (TDI)}}$$

For non-carcinogenic effects of COPCs, an ER of less than 0.2 represents exposure that does not pose a significant health risk to human receptors (Health Canada 2004b). Health Canada considers an ER value of 0.2 appropriate because only one exposure pathway is evaluated and it is assumed that people are exposed to COPCs from multiple sources such as other food groups, soil, air, water, cigarettes, and cigarette second-hand smoke.

ER values greater than 0.2 do not necessarily indicate that adverse health effects will occur, because of the conservatism employed in their estimation (e.g., the TRVs are conservative and protective of human health based on the application of uncertainty factors in their derivation). Thus, an ER value of greater than 0.2 is not conclusive evidence that a human health risk exists. However, it does suggest potential risk that may require a more detailed evaluation.

Table 6.2-1 presents the ER results based on the predicted and measured metal concentration in country foods. The ER values for toddlers and adults consuming moose, snowshoe hare, grouse meat and highbush cranberry were below 0.2 for all COPCs.

6.3 ESTIMATION OF CANCER RISKS

Carcinogenic risks were estimated as incremental lifetime cancer risk (ILCR) estimates according to the following formula:

$$\text{ILCR} = \text{(Estimated Lifetime Daily Intake)} \times \text{(Oral Slope Factor)}$$

The oral slope factor for cancer of inorganic arsenic is 0.03 mg/kg BW/day. The ELDI is calculated based on the following formula:

$$ELDI = \frac{IR \times F \times C_{food} \times YE}{LE \times BW}$$

Where,
ELDI = Estimated lifetime daily intake of arsenic (mg/kg BW/day)
IR = Ingestion rate of country food (kg/day)
F = Exposure frequency (unitless)
C_{food} = Arsenic concentration in country food (mg/kg)
YE = Years exposed (80 years)
LE = Life expectancy (80 years)
BW = Adult body weight (70.7 kg)

Table 6.2-1. Exposure Ratios for Human Receptors for the KSM Project

	Moose ER		Snowshoe Hare ER		Grouse ER		Highbush Cranberry ER	
Metals	**Toddler**	**Adult**	**Toddler**	**Adult**	**Toddler**	**Adult**	**Toddler**	**Adult**
Aluminum	1.18×10^{-01}	6.41×10^{-02}	5.38×10^{-05}	2.92×10^{-05}	9.74×10^{-03}	5.28×10^{-03}	6.49×10^{-03}	3.52×10^{-03}
Arsenic	2.66×10^{-02}	1.44×10^{-02}	1.18×10^{-05}	6.40×10^{-06}	1.67×10^{-03}	9.06×10^{-04}	4.58×10^{-04}	2.48×10^{-04}
Cadmium	3.62×10^{-03}	1.97×10^{-03}	2.40×10^{-06}	1.30×10^{-06}	1.40×10^{-03}	7.58×10^{-04}	5.72×10^{-04}	3.11×10^{-04}
Copper	1.57×10^{-02}	8.53×10^{-03}	7.89×10^{-06}	4.28×10^{-06}	1.40×10^{-04}	7.59×10^{-05}	1.71×10^{-03}	9.25×10^{-04}
Lead	2.71×10^{-03}	1.47×10^{-03}	1.23×10^{-06}	6.65×10^{-07}	8.33×10^{-04}	4.52×10^{-04}	6.41×10^{-04}	3.48×10^{-04}
Selenium	9.20×10^{-02}	4.99×10^{-02}	5.87×10^{-05}	3.19×10^{-05}	1.56×10^{-03}	8.46×10^{-04}	2.08×10^{-03}	1.13×10^{-03}
Zinc	8.78×10^{-02}	4.77×10^{-02}	5.66×10^{-05}	3.07×10^{-05}	1.16×10^{-03}	6.32×10^{-04}	5.00×10^{-04}	2.72×10^{-04}

Most parameters in the estimated lifetime daily intake (ELDI) calculation are also described for the EDI formula (i.e. IR, F, C_{food} and BW). The ELDI is the average arsenic intake per unit body weight over a lifetime (80 years).

An ILCR value equal to or less than 1×10^{-5} is considered "essentially negligible" by Health Canada and is defined as a cancer rate of 1 in 100,000 individuals who are exposed to the chemical of concern (Health Canada 2004c). Potential effects of the proposed Project on the ILCR are independent from background/baseline effects (Health Canada 2004c). Therefore, it is necessary to estimate the ILCR at baseline.

The results of the baseline ILCRs from exposure to arsenic in country foods are presented in Table 6.3-1. The ILCR for moose, snowshoe hare, grouse and highbush cranberry are less than 1×10^{-5} and are considered safe for consumption at the rates assumed in this assessment.

Table 6.3-1. Incremental Lifetime Cancer Risk for Human Receptors Exposed to Arsenic in Country Foods

Country Food	**Incremental Lifetime Cancer Risk**
Moose	4.33×10^{-07}
Snowshoe Hare	1.93×10^{-10}
Grouse	2.72×10^{-08}
Highbush Cranberry	7.45×10^{-09}

6.4 RECOMMENDED MAXIMUM WEEKLY INTAKES

The RMWIs were calculated as per Health Canada guidance, using the following equation:

$$RMWI = \frac{TRV \times BW \times 7}{C_{food}}$$

Where:
RMWI = recommended maximum weekly intake of food (kg/week)
TRV = toxicological reference value (mg/kg BW/day)
BW = receptor body weight (kg)
7 = days/week
C_{food} = 95% UCLM COPC concentration in food (mg/kg)

This equation was applied to each COPC and human receptor. The metal that had the lowest RMWI for each receptor was selected as the overall RMWI, because the lowest metal specific RMWI is the driver of potential risks. The lowest RMWI was converted to the recommended maximum weekly number of servings and compared to the current number of servings per week (based on Jin 2006) by country food harvesters and presented in Table 6.4-1.

The recommended maximum weekly number of servings for moose, snowshoe hare, grouse and highbush cranberry are greater than the assumed number of servings that adult and toddler country food harvesters are assumed to currently eat (based on Jin 2006). This means that the country foods harvesters can continue to consume the country foods at rates and frequencies which are assumed in this assessment.

Table 6.4-1. Recommended Maximum Weekly Number of Servings

Country Food	Human Receptor	Serving Size (kg)	Recommended Maximum Weekly Number of Servings	Current Number of Servings per Week
Moose	Toddler	0.0916	59	7
	Adult	0.213	109	7
Snowshoe Hare	Toddler	0.1496	978	0.06
	Adult	0.348	1801	0.06
Grouse	Toddler	0.1286	12	0.12
	Adult	0.299	22	0.12
Highbush Cranberry	Toddler	0.11	34	0.23
	Adult	0.26	62	0.23

7. Uncertainty Analysis

The process of evaluating human health risks from exposure to country foods involves multiple steps. Uncertainties inherent to each step ultimately affect the final risk estimates of the baseline assessment. These uncertainties may exist in numerous areas, including estimation of potential exposures and selection of toxicity reference values. These uncertainties may result in an over- or underestimation of risk. However, for this assessment, where uncertainties existed, a conservative approach was taken, where appropriate, to overestimate rather than underestimate potential risks from consuming country foods.

Some of the uncertainties have been mentioned in the preceding report sections. The following uncertainty analysis is a qualitative discussion of the potential significant sources of uncertainty in this assessment. There may be sources of uncertainty other than those evaluated here; however, their effect on the estimated risk is considered comparatively insignificant.

7.1 CONTAMINANTS OF POTENTIAL CONCERN

Metals were the focus of this assessment because the proposed Project is a base metals mine and base metals naturally occur in environmental media. The metals that were selected as COPCs were based on federal guidelines for metal concentrations in water and soil. Various types of water and soil guidelines exist. For example, the CCME provides water quality guidelines for drinking water, protection of aquatic life and protection of agricultural water uses. Soil guidelines include the protection of environmental and human health for agricultural, residential, parkland, commercial and industrial use.

As a conservative approach, the most stringent environmental guidelines were used as a screening tool to select the COPCs. These guidelines include the CCME water quality guidelines for the protection of aquatic life and the CCME soil quality guidelines for the protection of environmental and human health for residential and parkland use. This screening approach is conservative because it identifies the maximum number of metals to evaluate.

Non-metal COPCs such as persistent organic pollutants (i.e. pesticides) may be associated with project operations (i.e. maintenance of the power line which is proposed to go from Highway 37 to the plant site). Other substances used during Project construction, operation and closure may include petroleum hydrocarbons. The sources of such substances are anthropogenic in nature and do not exist naturally in the environment under baseline conditions. There could be trace levels from air vapour transport from other geographic regions, but the amount would not be substantial relative to levels resulting from direct use of a substance in the area. Thus, it is concluded that baseline COPCs related to country foods have been identified and evaluated in this assessment.

7.2 TISSUE CONCENTRATIONS

There are several uncertainties associated with modelled tissue concentrations used in this assessment. A description of these uncertainties is provided for wildlife and plants.

7.2.1 Moose, Snowshoe Hare and Grouse

No moose, snowshoe hare or grouse tissue samples were collected from the study area. In August 2009, Rescan attempted to contact guide outfitters in the study area to submit animal tissue samples during the hunting season. Telephone and email efforts were largely unsuccessful because the individuals did not respond to any communication attempts. The only response received was from Misty Mountain guide outfitters. This guide outfitter indicated that he would not be in the area during the hunting season and that he would not be able to provide any tissue samples. Therefore, in the absence of available tissue samples, a food chain model was used to predict metal concentrations in moose, snowshoe hare and grouse. As with all models, some uncertainties are associated with its use. The main uncertainties are:

- The biotransfer factors (BTFs) in the food chain model from soil-to-tissue were used for all exposure pathways in to moose, snowshoe hare and grouse. The soil-to-tissue BTF describes the amount of metals that are absorbed into the tissue when an animal consumes soil. While it is unlikely that the BTFs from plant-to-tissue and water-to-tissue are the same as soil-to-tissue, this method is the accepted way to model the uptake of COPCs into animals when empirical data is not available.
- There are no BTFs that are specific for moose, snowshoe hare and grouse. BTF values are derived from research of domestic food animals, rather than wildlife. In absence of BTF values for moose, snowshoe hare and grouse, substitute BTF values were used. For moose and snowshoe hare, another herbivore (cows) was used and BTF values for chickens were used for grouse.
- Moose, snowshoe hare and grouse diets were assumed to be composed of the stems and leave of all vegetation species collected during field studies. These plant parts may not be representative of the actual foods that these animals eat (e.g., grouse diet comprises berries, insects, and the needles and buds of conifer trees).

The predicted animal tissue concentrations were the largest source of uncertainty in this assessment. The uncertainty was primarily due to the accuracy of the model itself. The modelled values are largely dependent on the measured metal concentration in the soil, water and vegetation that was collected in the study area. A large sample size was used to calculate the 95% UCLM for soil and water. Therefore, the concentration of COPCs in soil and water likely represent the actual conditions in the study area. The soil and water in the study area is highly mineralized, and the model assumed that moose, snowshoe hare and grouse spend their entire lifetime within this area and consume this media. This approach is considered conservative as moose are not likely to remain within the boundaries of the study area and may move to areas with less mineralization in the water and soil.

The best method to increase the certainty of the metal concentrations in moose, snowshoe hare and grouse tissue would be to collect tissue samples for laboratory analysis. However, the guide outfitters either did not respond to Rescan's messages or were not active in the area during the survey period (and were therefore not able to provide samples) and harvesting animals strictly for the purposes of the baseline assessment is not considered necessary.

7.2.2 Highbush Cranberry

The berries of the highbush cranberry were collected for laboratory analysis to provide empirical metal concentrations. Three samples were collected from the study area for analysis. Ideally, a larger sample size would provide more certainty on the range of metal concentrations that exist in highbush cranberry in the study area. However, 2009 was a poor year for berry production in the area and additional samples could not be obtained. Due to the small sample size there is uncertainty that the concentration among the three samples is representative of the quality of highbush cranberry that country food harvesters would consume.

7.2.3 Quality Assurance and Quality Control

Quality assurance and quality control methodologies were followed during the sampling of the soil, water, vegetation and berries. All persons collecting the tissue samples were trained on appropriate tissue sampling techniques. This minimized the potential for cross-contamination and ensured that the sample sizes were adequate for chemical analyses. Vegetation tissue collectors were provided with all of the sterile field supplies and disinfectants required for collecting samples.

All chemistry samples were analyzed by ALS Laboratory Group (Environmental Division) in Burnaby, BC. ALS is certified by the Canadian Association of Environmental Analytical Laboratories. Chain of custody forms were completed and transported with all tissue samples that were sent to ALS. Quality assurance and quality control measures with respect to field blanks and related controls are provided in the water, soil and vegetation baseline studies. Overall, there is high certainty in the quality of the vegetation, water and soil data.

7.3 LOCATIONS OF COUNTRY FOODS HARVESTED

For the country foods assessed, it was assumed that 100% of the food consumed per year came from within the study area. During attempts to conduct country food interviews, most guide outfitters and trapline licence owners did not respond to communication attempts. Only one guide outfitter was confirmed to access the site regularly for harvesting. The guide outfitter had indicated that he had not seen adjacent trapline licence owners for at least 2 years and noted some individuals were currently working out of the country although they retain their trapline licence. This may suggest infrequent or inconsistent use of the area for harvesting country foods throughout the year and between years. Thus, the assuming that 100% of the country food consumed originates from the study area is a conservative estimate.

It is noted that, information on contemporary land use by Aboriginal peoples is pending and therefore there is some uncertainty about their use of the study area. By assuming 100% of the food is harvested from the study area, there is conservatism in the assessment.

7.4 COUNTRY FOODS CONSUMPTION AMOUNTS AND FREQUENCY

The serving size and exposure frequency data used in this assessment came from food consumption surveys of the Tahltan First Nation (Jin 2006). There is uncertainty in using these data as it is not site specific (i.e. it is based on Tahltan First Nation consumption from a wide range of areas within the Tahltan asserted territory). In addition, the data do not reflect the consumption of other country foods harvesters who may harvest from the area. For, moos the high frequency and amounts of consumption are considered to be overestimated rather than underestimated.

Consumption amounts and frequencies for toddlers also carry some uncertainty. As a conservative approach, it was assumed that toddlers ranging from 6 months to 4 years old consumed food at a rate of 43% of an adult based on literature recommendations (Richardson 1997). It is unlikely that toddlers consume roughly half the amount of food that an adult would. This uncertainty is important because the overestimation of food consumption results in the high ER value and current weekly number of servings in toddlers that consume moose tissue. It is probable that the actual exposure to COPCs from the ingestion of country foods is substantially lower for toddlers.

7.5 TOXICITY REFERENCE VALUES

There is uncertainty associated with estimating toxicity benchmarks by extrapolating potential effects on humans from animal studies in the laboratory. For human health risk assessments, it is a standard practice to assume that people are more sensitive to the toxic effects of a substance than laboratory animals. Therefore, the toxicity benchmarks for human health are set at much lower levels than the animal benchmarks (typically 100 to 1,000 times lower). This large margin ensures that doses less than the toxicity benchmarks are safe and that minor exceedances of these benchmarks (i.e., when the ER is greater than 1.0) are extremely unlikely to cause adverse health effects.

The TRVs are derived for individual contaminants. However, it is recognized that multiple chemicals may be present within a food item, and interactions between compounds may result in antagonism, additivity, or synergism. As the scientific understanding of the effects of multiple contaminants is still in its infancy, interactions were not evaluated in this assessment.

7.6 DEFINITION OF HEALTH

This country foods assessment is a science-based approach recommended by Health Canada. It should protect human receptors from adverse health effects from exposure to the selected COPCs. The country foods assessor recognizes that health is more than just physical health. For instance, social, nutritional, and economic factors as well as customs and practises also play a role in a persons overall health status.

8. Conclusion

This country foods assessment integrated the results of the environmental media baseline studies, contemporary consumption studies and regulatory-based indices of toxicity. The quality of country foods was estimated prior to development of the Project, and thus is reflective of baseline levels of metals in country foods. This baseline assessment will be used as a benchmark for predicting potential effects of the Project on country foods as part of the EA Application. The following presents a summary of the baseline assessment's findings.

The assessment focused on metals because the Project is a proposed gold/copper metal mine. Seven metals were selected for evaluation based on the levels that were measured in the soil and water in the study area. These metals were: aluminum, arsenic, cadmium, copper, lead, selenium and zinc.

Due to a lack of site specific harvest and consumption information, literature and other biological baseline information was consulted with respect to the selection of the country foods to assess as well as the consumption amounts and frequencies. Overall, the data used in this assessment has likely resulted in conservatism in the risk estimates. This is largely due to the lack of access to the Project area.

Metal concentrations were modelled in moose, snowshoe hare and grouse using a food chain model, while berry samples from highbush cranberry were collected and analyzed in a laboratory for metal concentrations. The modelled and measured metal concentrations were used to estimate the potential health risk from consuming country foods under baseline conditions.

This study predicted no unacceptable risks to people from the consumption of moose, snowshoe hare, grouse and highbush cranberry based on the assumed consumption rates of these foods by toddlers and adults.

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Appendix 1

Food Chain Model for Moose and Grouse

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Engineers and Scientists

APPENDIX 1
FOOD CHAIN MODEL FOR MOOSE AND GROUSE

Table of Contents

List of Tables

1. Introduction

A food chain model was used to predict the concentration of metals in moose and grouse muscle tissue because tissue samples from the Project area could not be obtained. The food chain model predicts metal concentrations in animal tissue by estimating the fraction of metals that are retained in the tissues when wildlife ingests environmental media such as vegetation, soil and surface water. The food chain model followed the methodology described in Golder Associates (2005).

This section provides details on the methodology of the food chain model and the modelled metal concentrations in the tissues of moose and grouse. The modelled metal concentrations are used in the country food assessment.

2. Methodology

The food chain model assumes that metal content in animal tissues is primarily the result of ingestion routes. Other exposure routes such as inhalation of metals in dust or dermal (skin) absorption are considered insignificant contributors relative to the ingestion pathway. The three main components of the ingestion route are the ingestion of surface water, vegetation and soil, which is trapped in the roots of consumed vegetation. The following equation was used to predict the metal concentration in animal tissue:

$$C_{food} = M_{water} + M_{veg} + M_{soil}$$

Where:
C_{food} = Modelled concentration of COPC in moose or grouse (mg/kg wwt).
M_{water} = COPC concentration in moose or grouse from the animal's exposure to metals in water.
M_{veg} = COPC concentration in moose or grouse from the animal's exposure to metals in vegetation.
M_{soil} = COPC concentration in moose or grouse from the animal's exposure to metals in soil.

To determine the COPC concentration that each environmental media contributes to the animal tissue, terrestrial wildlife uptake equations are used to quantify M_{water}, M_{veg} and M_{soil}. Table A-1 presents the equations to calculate the contribution of COPCs in wildlife tissue from the ingestion of each environmental media.

Table A-1. Terrestrial Wildlife Uptake Equations

Pathway	Equation and Parameters
Water ingestion	$M_{water} = BTF_{food\text{-}metal} \times C_{water} \times IR_{water}$
Vegetation ingestion	$M_{veg} = BTF_{food\text{-}metal} \times C_{veg} \times IR_{veg} \times f$
Soil ingestion	$M_{soil} = BTF_{food\text{-}metal} \times C_{soil} \times IR_{soil} \times f$

M = COPC concentration in moose or grouse from the animal's exposure to metals in environmental media (mg/kg wwt)
BTF = Species-specific Bio-transfer Factor for a metal (day/kg wwt)
IR = Ingestion Rate (kg/day or L/day)
C = Concentration of metal in media (mg/kg or mg/L)
f = fraction of daily consumption of soils and vegetation in the Project area (assumed to be 1)

2.1 TERRESTRIAL WILDLIFE CHARACTERISTICS

The terrestrial wildlife uptake equation recognizes that different wildlife species consumes environmental media at different ingestion rates. For example, moose ingests a greater amount of water per unit body weight relative to a grouse which minimizes water intake due to the weight constraints necessary to fly. Therefore, ingestion rates (IR) for each media type is species-specific for animals. Table A-2 presents the species-specific characteristics that were used to predict COPC concentrations in muscle tissue. It was assumed that moose and grouse spend all year eating and drinking from within the Project area (f = 1).

Table A-2. Terrestrial Wildlife Characteristics

Receptor	Body Weight (kg)	Total Ingestion Rate (kg/day)	Water Ingestion Rate (IR_{water}) (L/day)	Vegetation Ingestion Rate (IR_{veg}) (kg/day)	Soil Ingestion Rate (IR_{soil}) (kg/day)
Moose	461	9.95	25	9.8	0.15
Grouse	1.2	0.085	0.07	0.084	0.001

2.2 METAL CONCENTRATIONS IN ENVIRONMENTAL MEDIA

Rescan conducted field studies to determine the baseline metal concentrations in the soil, water and vegetation of the Project area. The 95% upper confidence limit of the mean (95% UCLM) was calculated for each metal in water, vegetation and soil. The 95% UCLM encompasses the range of variability of detected concentrations, which is a more reasonable representation of metal concentrations that animals are exposed to. The 95% UCLMs were calculated using ProUCL software, which was developed and recommended by the United States Environmental Protection Agency (US EPA 2007). Table A-3 presents the 95% UCLM metal concentrations in water, vegetation and soil.

These concentrations were used to predict the concentrations in moose and grouse for the food chain model. A summary of the data is presented in Table A-3.

Table A-3. Summary of 95% UCLM Metal Concentrations in Surface Water, Soil and Plant Tissue

COPC	Soil 95% UCLM (C_{soil}) (mg/kg)	Water 95% UCLM (C_{water}) (mg/L)	Vegetation 95% UCLM (C_{veg}) (mg/kg)
Aluminum	26,586	2.74	21.32
Arsenic	37.44	0.01	0.0141
Cadmium	0.541	0.0014	0.155
Copper	160.1	0.13	1.241
Iron	58,506	6.08	19.11
Lead	27.31	0.0041	0.0178
Selenium	1.956	0.0014	0.153
Zinc	94.57	0.1	9.631

2.3 BIOTRANSFER FACTORS

The terrestrial wildlife uptake equation also recognizes that the metal absorption rates or bio-transfer rates (BTF) are different between wildlife species. Typically, BTF values are developed for agriculturally important food animals. No data on moose BTFs were available; therefore BTF values for cows, the closest related herbivorous ungulate, was used (RAIS 2009). For grouse BTFs, the closest avian species, chickens, was used (PNNL 2003). When chicken BTF values were not available, a metal with similar physiochemical properties in the same column of the periodic table of elements was used. For example, there is no chicken BTF value for aluminum, therefore the BTF value of gallium, which is below aluminum on the periodic table, was used in its place. Table A-4 presents the BTF values for cows and chickens.

Table A-4. Biotransfer Factors (day/kg wwt)

COPC	BTF_{cow}	$BTF_{chicken}$
Aluminum	0.0015	0.8
Arsenic	0.002	0.83
Cadmium	0.0004	0.8
Copper	0.009	0.5
Iron	0.02	1
Lead	0.0004	0.8
Selenium	0.1	9
Zinc	0.1	7

3. Results

Table A-5 provides a sample calculation of the aluminum concentrations in moose muscle tissue. Table A-6 presents the modelled metal concentrations in the tissues of moose and grouse. The modelled results represent the quality of moose and grouse in the Project area that country food harvesters would consume.

Table A-5. Sample Calculation of Aluminum Concentration in Moose Muscle Tissue from Exposure to Soil, Vegetation and Water

C_{food}	=	M_{water}	+	M_{veg}	+	M_{soil}				
and:	=									
M_{water}	=	$BTF_{food\text{-}metal}$	x	C_{water}	x	IR_{water}				
M_{veg}	=	$BTF_{food\text{-}metal}$	x	C_{veg}	x	IR_{veg}	x	f		
M_{soil}	=	$BTF_{food\text{-}metal}$	x	C_{soil}	x	IR_{soil}	x	f		
Where:										
C_{food}	=	Total concentration of COPC in meat tissue from soil, vegetation and water consumption								
M_{water}	=	Concentration of COPC in meat tissue from water consumption								
M_{veg}	=	Concentration of COPC in meat tissue from vegetation consumption								
M_{soil}	=	Concentration of COPC in meat tissue from soil consumption								
$BTF_{food\text{-}metal}$	=	Bio-transfer factor from food consumption to tissues for a selected metal								
C	=	Concentration of metal in media								
IR	=	Ingestion rate of media								
f	=	fraction of food ingestion rate from Project area (assumed to be 1)								
Calculation:										
M_{water}	=	(0.0015 day/kg wwt)	x	(2.74 mg/L)	x	(25 L/day)				= 0.10275 mg/kg wwt
M_{veg}	=	(0.0015 day/kg wwt)	x	(21.32 mg/kg)	x	(9.8 kg/day)	x		1	= 0.31340 mg/kg wwt
M_{soil}	=	(0.0015 day/kg wwt)	x	(26,586 mg/kg)	x	(0.15 kg/day)	x		1	= 5.98185 mg/kg wwt
C_{food}	=	(0.10275 mg/kg wwt)	+	(0.31340 mg/kg wwt)	+	(5.98185 mg/kg wwt)				= 6.398 mg/kg wwt

Table A-6. Modelled Metal Concentrations in Moose and Grouse Tissue

COPC	C_{moose} (mg/kg wwt)	C_{grouse} (mg/kg wwt)
Aluminum	6.40×10^{0}	2.29×10^{1}
Arsenic	1.20×10^{-2}	3.26×10^{-2}
Cadmium	6.54×10^{-4}	1.09×10^{-2}
Copper	3.55×10^{-1}	1.37×10^{-1}
Iron	1.82×10^{2}	6.05×10^{1}
Lead	1.75×10^{-3}	2.33×10^{-2}
Selenium	1.83×10^{-1}	1.34×10^{-1}
Zinc	1.11×10^{1}	6.37×10^{0}

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Appendix 2

Laboratory Analytical Results for Highbush Cranberry, 2008

Appendix 2. Laboratory Analysis for Highbush Cranberry, 2008

Analysis Results			
Sample ID	TREATY 1	TREATY 2	GILBERT
Date Sampled	9-Sep-08	7-Sep-08	7-Sep-08
ALS Sample ID	L748697-1	L748697-2	L748697-3
Matrix	Berries	Berries	Berries
Physical Tests			
% Moisture	84.9	88.7	90.8
Metals (mg/kg wwt)			
Aluminum (Al)	8.5	4.5	3.8
Antimony (Sb)	<0.010	<0.010	<0.010
Arsenic (As)	<0.010	<0.010	<0.010
Barium (Ba)	2.67	2.16	1.60
Beryllium (Be)	<0.10	<0.10	<0.10
Bismuth (Bi)	<0.030	<0.030	<0.030
Cadmium (Cd)	<2.0	<2.0	<2.0
Calcium (Ca)	<0.0050	<0.0050	<0.0050
Chromium (Cr)	177	138	158
Cobalt (Co)	<0.10	<0.10	<0.10
Copper (Cu)	<0.020	<0.020	<0.020
Iron (Fe)	0.931	0.462	0.578
Lead (Pb)	7.72	2.71	1.67
Lithium (Li)	<0.020	<0.020	<0.020
Magnesium (Mg)	<0.10	<0.10	<0.10
Manganese (Mn)	118	75.4	80.8
Mercury (Hg)	26.4	24.8	23.8
Molybdenum (Mo)	<0.0010	<0.0010	<0.0010
Nickel (Ni)	0.049	0.03	0.15
Phosphorus (P)	0.18	<0.10	<0.10
Potassium (K)	283	183	143
Selenium (Se)	1190	860	741
Sodium (Na)	<0.20	<0.20	<0.20
Strontium (Sr)	<0.010	<0.010	<0.010
Thallium (Tl)	<20	<20	<20
Tin (Sn)	0.766	0.665	0.406
Titanium (Ti)	<0.010	<0.010	<0.010
Uranium (U)	<0.050	<0.050	<0.050
Vanadium (V)	0.18	0.23	<0.10
Zinc (Zn)	<0.0020	<0.0020	<0.0020
Vanadium (V)	<0.10	<0.10	<0.10
Zinc (Zn)	1.53	0.74	1.03

Appendix 3

Sample Calculation of the Estimated Daily Intake

Appendix 3. Sample Calculation of the Estimated Daily Intake

Sample Calculation of Selenium EDI for Toddlers Consuming Moose Meat

$$EDI_{Se} = \frac{IR_{toddler} \times C_{moose} \times F}{BW_{toddler}}$$

Parameters

EDI_{Fe}	=	Estimated daily intake of iron (mg/kg BW/day)
$IR_{toddler}$	=	Ingestion rate of moose by toddlers (kg wwt/day)
C_{moose}	=	Concentration of iron in moose tissue (mg/kg wwt)
F	=	Exposure Frequency (364 of 365 days per year)
$BW_{toddler}$	=	Body weight of a toddler (kg BW)

$$EDI_{Se} = \frac{(0.0916 \text{ kg wwt/day}) \times (0.182 \text{ mg/kg wwt}) \times (0.996)}{(16.5 \text{ kg BW})}$$

$$EDI_{Se} = 0.001 \text{ mg/kg BW/day}$$