# SUMMARY REPORT

# ANVIL RANGE MINE
# TIER 2 RISK ASSESSMENT OF CURRENT CONDITIONS

**Prepared for:**

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## INTRODUCTION

The Interim Receiver for the Anvil Range Mine Complex commissioned SENES Consultants Limited to carry out an assessment of the potential for metals present at the site in groundwater, surface water, sediments, soils, fish, and vegetation to harm animals on and close to the site as well as people who use the site for hunting, trapping and gathering. The assessment was undertaken to assist the closure planning team in the development of remediation options for the site. The Anvil Range Mine Complex includes facilities at two locations, the Faro mine site and the Grum and Vangorda mine site. The Faro mine site is located within the Rose Creek watershed, a tributary of the Anvil Creek watershed, while the Grum and Vangorda mine site is located within the Vangorda Creek watershed. The Anvil Creek and Vangorda Creek watersheds both empty into the Pelly River.

A selection process was used to identify metals that may have the potential to cause harm at the Anvil Range Mine Complex. The process involved determining whether the concentrations of metals in water and soils were different from areas which were considered not to be affected by mining operations (these areas are termed background or reference levels). If the concentrations were higher than background, they were then compared to guideline values established by the federal government. Metals which were present at concentrations above these guideline values were then considered in the risk assessment. Based on this screening procedure: arsenic; cadmium; copper; lead; manganese; nickel; silver; tin; thallium; and zinc were identified and carried forward in the assessment.

Risks associated with direct exposure to waste materials (tailings and/or waste rock) were not assessed.

### *Data Used in the Assessment*

An assessment was carried out for existing metal concentrations at the site to serve as a baseline for determining the appropriate remedial options. The assessment of the current conditions on the site was based largely on data collected during the 2002 to 2004 period on the Rose Creek and Vangorda Creek watersheds as well as on the land at the Anvil Range Mine Complex. Some data from the 2005 sampling program were also used in the assessment. For example, water quality data collected in 2005 were used in the assessment. Additionally as they were made available, data on ungulates (sheep, moose and caribou), data on small mammals (beaver, hoary marmot, and muskrat) and data on birds (ptarmigan and grouse) were also considered in the assessment. A majority of data used in the assessment however, was based on monitoring carried out in 2004 as site conditions did not change much between 2004 and 2005 and not all of the data from the 2005 program was available at the time that the assessment was carried out.

Metal concentrations in air were collected in 2005; however, the results of the study were inconclusive and thus were not used in the risk assessment. Typically exposures from dust in the air represent a very small portion of the total amount of metals taken in by humans or animals; therefore, not using the results from the inconclusive study does not affect the results of the risk assessment.

### AQUATIC ENVIRONMENT ASSESSMENT

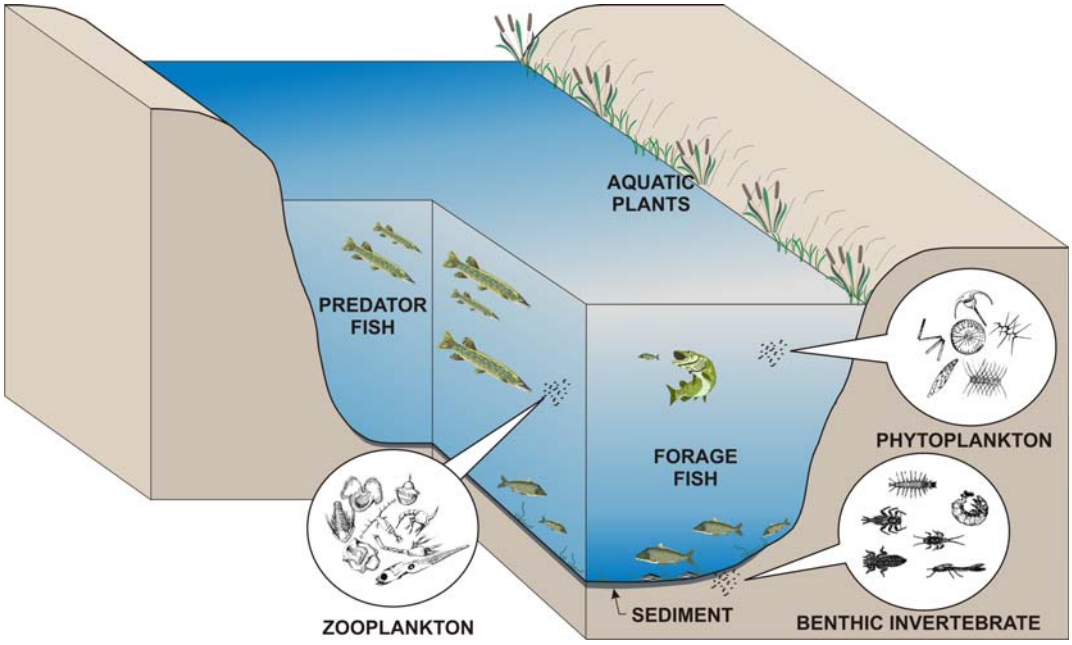
The aquatic environment assessment considered aquatic plants (plants that live along the edge of the water), phytoplankton (small plants that live in the water), zooplankton (small animals that live in the water), benthic organisms (small animals that live in the sediments) and fish (predatory and forage) that would come in contact (exposed) with metals in the water as seen in Figure 1. Both the upstream and downstream areas of Rose Creek and Vangorda Creek as well as Anvil Creek and the Pelly River were considered in the assessment. Effects on the health of aquatic species were determined by comparing the measured and predicted concentrations of metals in water to concentrations that are considered to protect these species. If the metal concentrations are below the protective levels then it can be concluded that the aquatic species are protected. This comparison is typically used in risk assessments.

### TERRESTRIAL ENVIRONMENT ASSESSMENT

The selection of terrestrial animals to carry through the risk assessment was based on information provided by the Terrestrial Environment study team who held discussions as part of their program with the First Nations people who use the site. The species selected included bear, caribou, waterfowl (mallard, merganser and scaup), small furbearers (beaver and mink), fox, grouse, hare, hoary marmot, moose, Fannin sheep and wolf. From a risk assessment point of view, the ways (pathways) that the animals identified above come in contact with the metals present at the Anvil Range Mine Complex cover all possible means of exposure for any other animals that may be present in the study area. The exposure pathways that were used in the assessment for all animals are identified on Figures 2a to 2d, which also show the amount of food, water and soil or sediment that each animal eats.

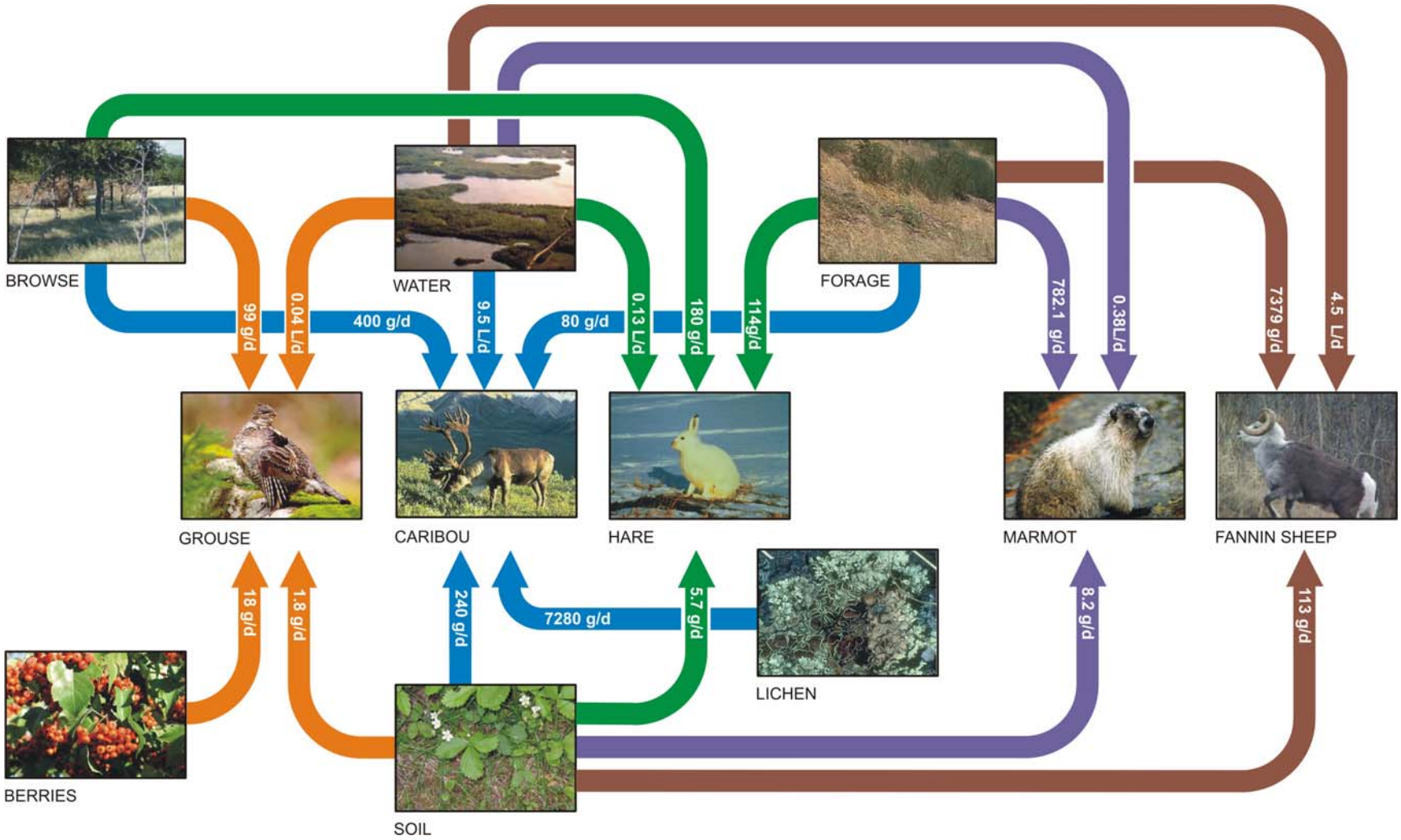
As described above, measured data was used as much as possible in the assessment. There were no data available for aquatic plants and thus literature-based factors were used to estimate the amount of metals in the aquatic plants based on measured metal concentrations in surface water. As seen from the figures, small mammals such as shrews, squirrels and voles were not considered to be consumed by animals that consume meat, such as fox, mink or wolf. This was because data for these species were not available at the time of the assessment. Therefore, a separate calculation was done using the maximum measured metal concentrations in these small mammals. The use of the measured data for the small mammals did not result in a significant change in intakes of metals for the fox, mink or wolf.

**FIGURE 1**
**AQUATIC RECEPTORS CONSIDERED IN THE ASSESSMENT**



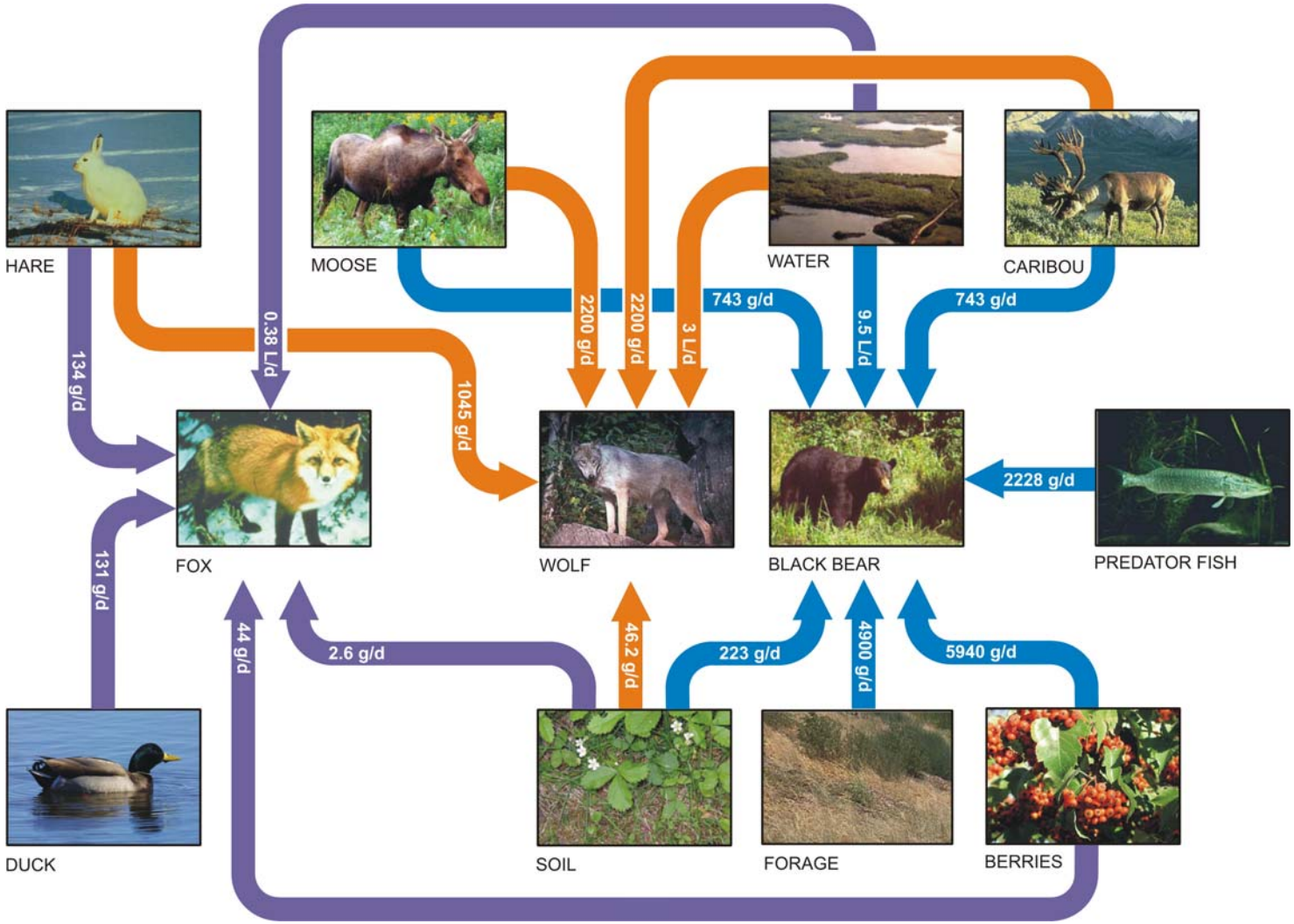

The site was divided into different areas depending on the distance that each animal typically travels from day to day. Small terrestrial mammals such as hare, grouse and marmot, do not move over large distances and therefore were considered at several different locations across the site as seen in Figure 3. Fox and bear which travel larger distances were considered in larger areas on the site (see Figure 3) and animals such as caribou, moose and wolf that travel long distances were considered to move across the whole site (see Figure 3). Sheep were evaluated in the Mount Mye area and part of the Vangorda mine site. Terrestrial animals that have a large aquatic based diet such as waterfowl and small furbearers were evaluated on Rose Creek, Vangorda Creek, Anvil Creek and the Pelly River. Potential health effects in terrestrial animals were determined by calculating the intake for each animal (i.e. the amount of metal consumed) and comparing it to a level that results in minor health effects in laboratory species (generally rats). Test species such as rats are used because there is very little data available on wildlife. If the estimated metal intakes are below levels that have been found in test animals to result in only minor health effects, then it can be concluded that the populations of these animals are not at risk of health effects.

**FIGURE 2a**
**POTENTIAL PATHWAYS OF EXPOSURE FOR CARIBOU, GROUSE, HARE, MARMOT AND SHEEP**



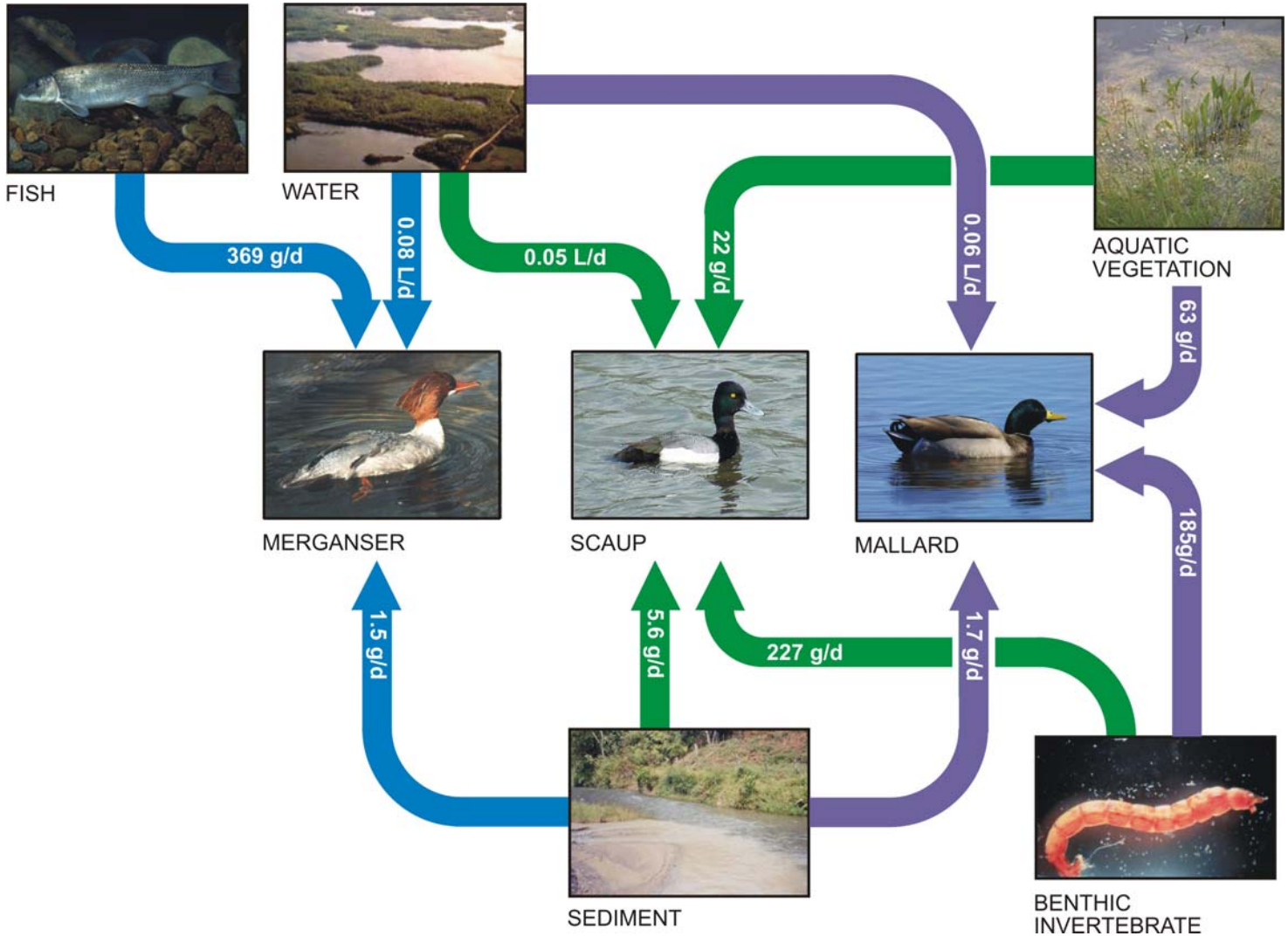

Note: All intakes are on a wet weight basis except for soil which is on a dry weight basis

**FIGURE 2b**
**POTENTIAL PATHWAYS OF EXPOSURE FOR BLACK BEAR, FOX AND WOLF**



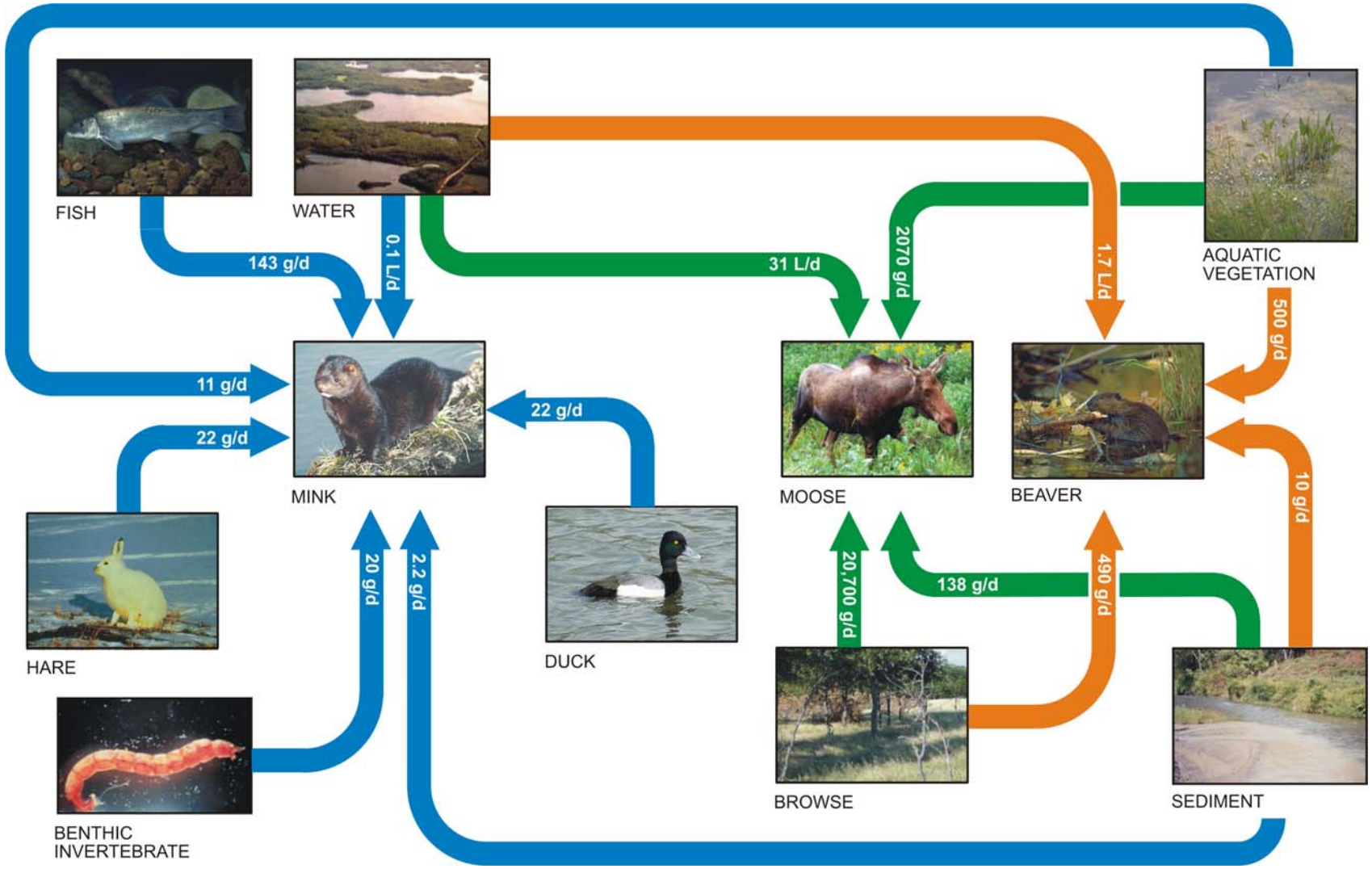

Note: All intakes are on a wet weight basis except for soil which is on a dry weight basis

**FIGURE 2c**
**POTENTIAL PATHWAYS OF EXPOSURE FOR MALLARD, MERGANSER AND SCAUP**



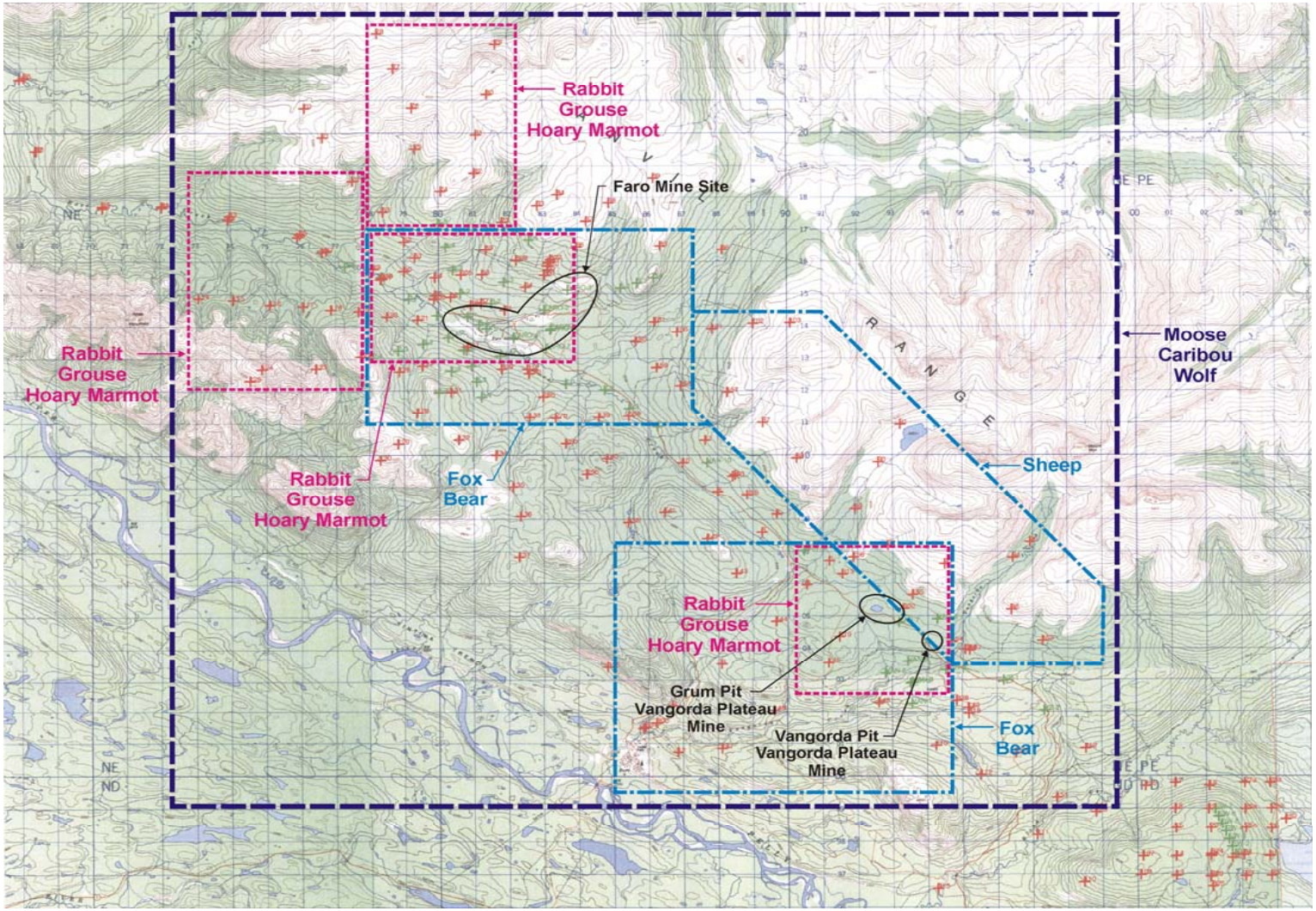

Note: All intakes are on a wet weight basis except for sediment which is on a dry weight basis

**FIGURE 2d**
**POTENTIAL PATHWAYS OF EXPOSURE FOR MINK, MOOSE AND BEAVER**




Note: All intakes are on a wet weight basis except for sediment which is on a dry weight basis

**FIGURE 3**
**LOCATIONS CONSIDERED IN TERRESTRIAL ASSESSMENT**




Note: + - soil and vegetation sampling locations

**HUMAN HEALTH ASSESSMENT**

The assessment of potential health effects to people who use the site for hunting, gathering and trapping considered that individuals (toddler, child, adult) may camp at the site for 1.5 months. Currently, based on information from the study team and published studies, the site is only used for gathering of berries, hunting and trapping; therefore, it was considered that individuals would trap small mammals, hunt large animals and gather berries from around the Faro mine site but would not camp on or near the Faro or Vangorda mine sites. For comparison, it was assumed that individuals would also be present in the Swim Lakes area for 1.5 months per year and would trap and gather berries from this baseline reference area but hunt large game on the Anvil Range mine site. Table 1 provides a summary of the assumptions used for the human health assessment. All individuals who hunt or trap at the site were assumed to take game and fish back to their communities and eat them year-round.

The different considerations or pathways of exposure that went into determining the amount of a metal that an individual may be exposed to is illustrated in Figure 4. These considerations were based on traditional knowledge that was gathered by the Terrestrial Effects study team, dietary information from a survey of First Nations people in the Yukon as well as professional judgement. As seen from the figure, it has been assumed that individuals would hunt, fish and trap animals in the study area. It was also assumed that gathering of berries and medicinal plants would occur at the Anvil Range Mine Complex. Other information required for the risk assessment such as the amount of water consumed by an individual, the amount of soil an individual may consume, the amount of skin available for contact and the body weight of an individual was obtained from data on the general Canadian population for various age ranges (i.e. 5 to 11 yr olds, 19 years and older).

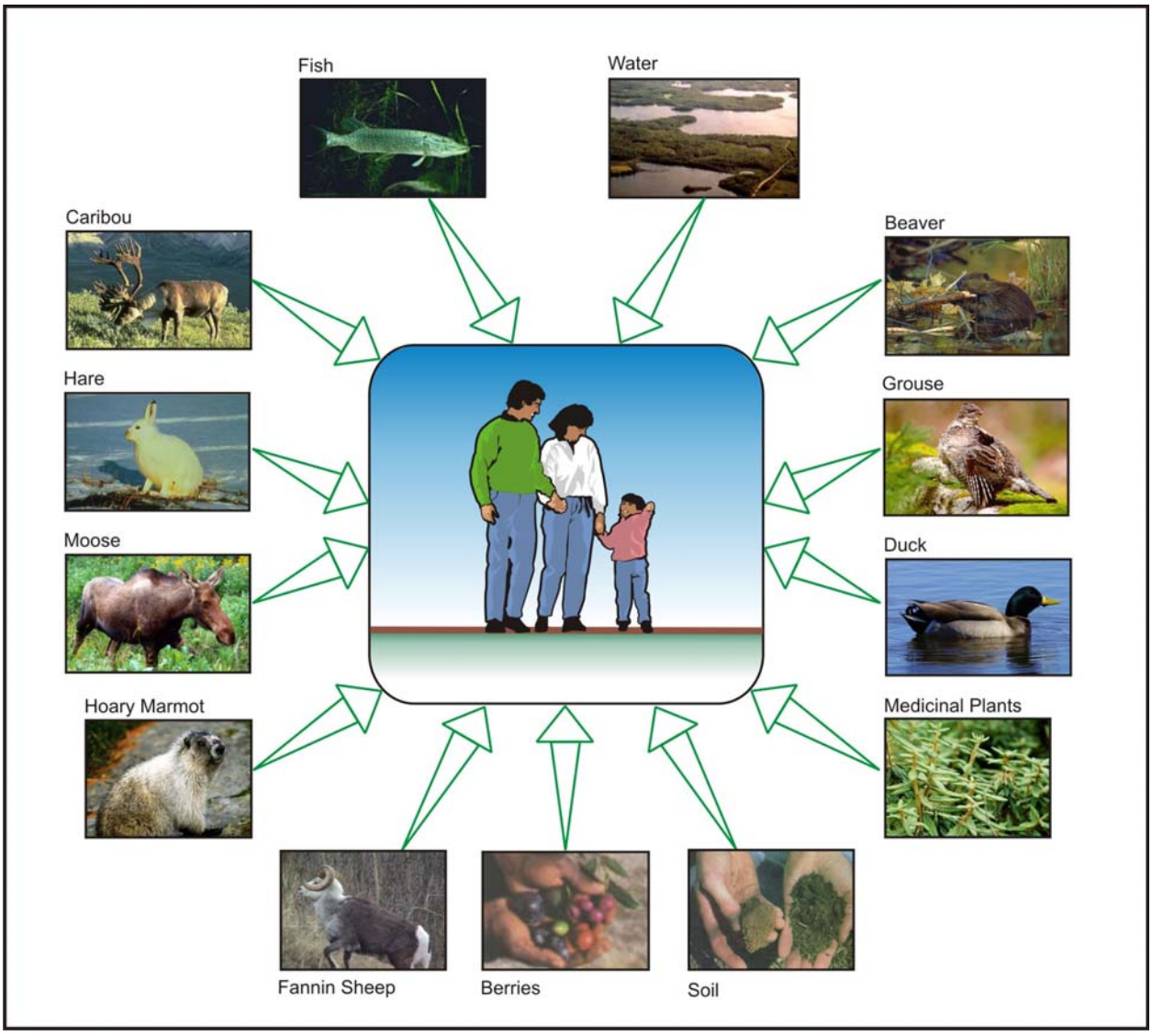
Measured concentrations of metals in caribou and moose captured at the site were used in the assessment. Measured metal concentrations in beaver, grouse and hoary marmot were not available at the time the risk assessment was undertaken; therefore, modelled concentrations were used in the assessment. The modelled concentrations were based on values reported in the literature for transfer from food to animal flesh. When measured levels subsequently became available, a comparison between the measured and the modelled muscle (flesh) concentrations for these thee animals was made. The comparison showed that in some cases the model over-estimated the concentrations and in other cases, the concentrations were underestimated. However, the metal intakes related to these three animals accounted for less than 0.5% of the metal intake to the humans, therefore not using the measured data for these three animals does not change the outcome of the assessment. Measured concentrations of metals in Labrador Tea were used in the assessment as a substitute for medicinal plants. This was considered to be a good substitute as the metal concentrations in the Labrador Tea were higher than concentrations measured in other medicinal plants or plant parts (i.e. sap).

**TABLE 1**
**LOCATION OF THE VARIOUS DIETARY COMPONENTS FOR THE HUMAN RECEPTORS**

| Receptor | Drinking Water | Fish/Ducks | Large Mammals | Small Mammals | Sheep | Berries/Medicinal Plants | Soil | Time on Site (months) |
|---|---|---|---|---|---|---|---|---|
| Camper 1 | Pelly River (Background) | Pelly River (Background) | Site Wide | Area close to the Faro Mine site | Sheep (Mt Mye) | Faro site | Area to west of the Faro Mine site | 1.5 |
| Camper 2 | Pelly River above Vangorda Creek | Pelly River above Vangorda Creek | Site Wide | Background | Sheep (Mt Mye) | Background | Background | 1.5 |

The risk of health effects from exposure to metals that are known not to cause cancer was evaluated by a comparison of the calculated metal intakes by individuals to reference metal intakes that are considered to result in no health effects. Intakes for metals that do not result in health effects are provided by regulatory agencies such as Health Canada. For cancer causing metals such as arsenic, the calculated risks were compared to an "acceptable" risk level of one-in-one hundred thousand as provided by Health Canada.

**FIGURE 4**
**POTENTIAL PATHWAYS OF EXPOSURE FOR HUMAN RECEPTORS**



## SUMMARY OF RESULTS

The risk assessment was undertaken using measured data where available from the site. There is a very good database for water, soils/sediments, fish, and terrestrial vegetation that provides a good description of existing conditions at the mine site and in the surrounding environment.

The Terrestrial Effects study indicates that there exist elevated levels of metals in the terrestrial environment in the mine area at the Anvil Mine Complex as a result of past mining activities as well as ongoing deposition (tailings and mill area). In the aquatic environment, there is also ongoing discharge. However, the results of the risk assessment, considering these elevated levels, indicate that no adverse health effects are expected in fish, and animals that are currently present on the site. The human health assessment indicates that humans who use the site for approximately 1.5 months of the year to gather berries and trap animals and who hunt animals on the site and eat them year round are not at risk from adverse health effects. Moose consumed from the Anvil Mine Complex represents a major portion of the diet. However, the human health risk assessment indicated that consumption of caribou and moose organs, which accumulate cadmium, could pose a risk of health effects. The cadmium in the organs of moose and caribou collected on the site are not related to exposure at the Anvil mine complex since they are not significantly different from animals collected from other areas in the Yukon and Northwest Territories.

As with all risk assessments, the collection of additional data always helps to improve the assessment. In the future, it would be helpful to collect additional information from the site to reduce some assumptions used in the assessment. For example, it would be most useful to survey the local community to determine the extent of current usage of the site, potential future usage of the site following remediation and the dietary characteristics of the First Nation people who hunt, gather and trap at the site.