11 ENVIRONMENTAL HEALTH

11.1 SCOPE OF ASSESSMENT

This section includes human and wildlife health

Environmental Health (Section 11) of the Snap Lake Diamond Project environmental assessment (EA) evaluates the potential for human and wildlife health effects resulting from emissions from the De Beers Canada Mining Inc. (De Beers) Snap Lake Diamond Project.

11.1.1 Terms of Reference

The Terms of Reference for the Environmental Health component

The final Terms of Reference provided by the Mackenzie Valley Environmental Impact Review Board (MVEIRB) for the Environmental Health component of the Snap Lake Diamond Project EA are provided in Table 11.1-1.

Table 11.1-1 Terms of Reference for Environmental Health

TOR Section	Environmental Assessment or Topic
2.5.2	**Description of the Existing Environment** De Beers will be expected to clearly and succinctly describe the following environmental components, as they relate to the proposed development: VIII. human health;
2.6.1	**Air Quality and Climate** The analysis should also include: IV. impact on biological receptors such as vegetation and wildlife;
2.6.4.2	**General Water** The assessment of proposed development impacts on water quality should also consider: III. kimberlite toxicity and implications for aquatic wildlife.
2.6.6	**Wildlife and Wildlife Habitat** The environmental assessment report should provide an analysis of the proposed development's impacts, (both direct and indirect), on wildlife and wildlife habitats, including migratory birds, giving consideration to and demonstrating linkages between predicted physical and biological changes resulting from the proposed development The analysis of development should include: VII. direct wildlife mortality; VIII. indirect wildlife mortality; IX. reduction in wildlife productivity;
2.7.4	**Human Health** The environmental assessment report shall analyze the potential development impacts upon the physical, mental, spiritual and cultural health of employees, their families and communities.

Source: Terms of Reference and Work Plan for the Environmental Assessment of the De Beers Canada Mining Inc. Snap Lake Diamond Project, September 20, 2001. Issued by: MVEIRB.

This section addresses physical health only

This section addresses the physical health of the employees, their families and communities that may be affected by changes to the environment. Mental, spiritual and cultural health are addressed in the Socio-economic Impact Assessment (Section 5.3).

There are no explicit terms of reference for wildlife health

There are no explicit Terms of Reference for wildlife health. However, an analysis of direct and indirect mortality is required (Section 2.6.6 in MVEIRB 2001):

Non-lethal effects on wildlife health are analyzed

Exposure to chemicals from the Snap Lake Diamond Project would not be high enough to cause mortality to wildlife. This is discussed in further detail in Wildlife (Section 10.4.2.4). For this reason, the wildlife health assessment focussed on an analysis of the potential for non-lethal effects (*e.g.*, decreased growth rate). This assessment goes beyond the Terms of Reference but is appropriate because human and wildlife exposure to chemicals was identified as an issue by Elders (Section 11.1.3.1). Issues related to fish health are addressed in Section 9.5.2.4.

11.1.2 Component Description and Organization

This health impact analysis evaluates the potential for exposure and effects on human and wildlife health

The human and wildlife health impact assessment is based upon the results of the air quality, water quality, vegetation, and wildlife assessments. It takes the results of these assessments and considers two aspects of environmental health:

- the potential for effects on wildlife health from exposure to chemicals in air, water, soil, and food; and,
- the potential for effects on human health from exposure to chemicals in air, water, soil, and traditional food (fish, game, plants).

The key questions address physical health of individuals and wildlife exposed to the environment

The key questions address the physical health of individuals and wildlife exposed to chemicals in the environment generated by the Snap Lake Diamond Project. Occupational health and safety is addressed as part of De Beers' corporate commitments and regulatory compliance (Sections 1.1 and 14, and Appendix I.1).

Section 11 includes the scope of assessment, baseline, and impact assessment

Section 11.1, the scope of assessment, includes the assessment approach, study area considerations, and assessment methodology. The baseline, which describes the environment prior to the project, is summarized in Section 11.2. The wildlife and human health impact assessments of chemical exposure, including food chain modelling, from the Snap Lake Diamond Project are presented in Section 11.3. All potential linkages between chemicals released by the Snap Lake Diamond Project and human and wildlife health are addressed in the impact assessment. The overall effect of the Snap Lake Diamond Project on human and wildlife health and the certainty of this prediction are presented in the conclusions (Section 11.4).

11.1.3 Assessment Approach

11.1.3.1 Key Issues and Key Questions

Additional guidance on key issues was sought

The Terms of Reference for human health are very general; therefore, additional guidance on key issues was sought from public consultation and traditional knowledge consultation (see Section 4).

Because of traditional reliance on animals, wildlife health issues are also human health issues

The traditional knowledge studies link people's health with the health of the land. Even though human health is not explicitly discussed or identified as an issue in either the Yellowknives Dene or the Lutsel K'e Dene Elders' traditional knowledge work, the prime importance of the health of plants and animals to people's way of life was emphasized. Because of people's reliance on animals as a food source, issues related to plant and animal health translates into human health issues.

> *Perhaps the most important aspect of community health (Dene ch'anie) relates to the land and land use …. Harvesting of traditional food defined the relationships people had with the land* (Lutsel K'e Dene First Nation 1999).

> *It would be unhealthy, I know….country food is more healthier food to eat than what we have in the stores. Maybe send that message out and go from there. Lots of Métis they still like fish and caribou and moose and geese. All these people I know that grew up here, they still like to eat those same country foods* (Leon Bloomstrand, North Slave Métis Alliance, not dated).

The following issues are addressed in this environmental health assessment

The following issues identified through consultation (issues presented in Appendix IV-1) are addressed in the human and wildlife health impact assessment (location of the information is provided in parentheses):

- identify and evaluate locations at the Snap Lake Diamond Project where wildlife could potentially be directly exposed to chemicals (*e.g.*, drinking water) (Section 11.3.2);

- identify and evaluate indirect wildlife exposure sources of chemicals emitted by the Snap Lake Diamond Project (*e.g.*, dust deposition on lichen) (Section 11.3.2);
- discuss the potential for changes to water quality, air quality, and the bioaccumulation of contaminants in traditional food sources in the study area to increase human exposure to contaminants (Section 11.3.3); and,
- identify those aspects of the Snap Lake Diamond Project that may have implications for human health and discuss the measures to be taken to prevent or minimize the potential for adverse health effects (Section 11.3.3).

Two key questions are derived from the issues

These issues are consolidated into two key questions. Key Questions EH-1 and EH-2 for the health impact assessment of the Snap Lake Diamond Project are as follows:

Key Question EH-1: What impacts will the Snap Lake Diamond Project have on wildlife health?

Key Question EH-2: What impacts will the Snap Lake Diamond Project have on human health?

11.1.3.2 Assessment Cases

The health impact assessment evaluated the potential for chronic effects from exposure to baseline and project chemicals

The human and wildlife health impact assessment evaluated the potential for long-term (or chronic) effects of chemical exposures on health. The maximum predicted concentrations of chemicals from routine emissions would not be high enough to cause short-term (acute) effects on health (*e.g.*, poisoning or acute allergy attacks). Effects due to accidental spills are discussed in Section 10.4. The following three exposure cases (*i.e.*, scenarios) were evaluated:

- exposure to baseline chemical emissions from existing sources (*i.e.*, the baseline case);
- exposure to combined chemical emissions from baseline sources and the Snap Lake Diamond Project operational phase (*i.e.*, the application case); and,
- exposure to emissions associated with post-closure (*i.e.*, post-closure case).

The construction phase was not addressed separately unless health risks were identified after 25 years of exposure

The construction phase was not evaluated because it occurs over a short period of time and concentrations of chemicals would not be high enough to cause acute health effects (Section 7.3.6). The human and wildlife health impact assessments evaluate chronic (*i.e*., long-term) exposure. If no health impacts are predicted for 25 years of exposure to emissions from the Snap Lake Diamond Project, then it is expected that no health impacts would occur during three years of construction under similar exposure levels. If health risks are predicted for the operation phase then an assessment would be conducted for the construction phase to ensure that concentrations of chemicals are less than toxicity benchmark values during that time period.

Closure was assessed for the north lakes

Impacts to lakes north of Snap Lake (arbitrarily identified as the north lake and the northeast lake) may occur during post-closure due to groundwater seepage (Sections 9.2 and 9.4). Changes in water quality are predicted to be greater in the north lake than the northeast lake. Therefore, wildlife and human health were evaluated for potential exposure to the north lake as the worst-case scenario for the post-closure case. If no health effects are predicted for exposure to the north lake, then no health effects are assumed for exposure to the northeast lake. All other emissions (*i.e.*, air emissions and direct water discharges to Snap Lake) will cease post-closure (Section 7.3 and 9.4).

See Section 12 for cumulative effects

Exposure to cumulative chemical emissions from all existing, approved, and planned developments (*i.e.*, the cumulative effects assessment [CEA] case) is addressed in Section 12.

11.1.4 Study Areas

Impacts on health were evaluated on local and regional scales

Impacts on human and wildlife health were evaluated on local and regional scales of the Snap Lake Diamond Project. Therefore, two study areas have been adopted as shown in Figures 11.1-1 and 11.1-2.

The local study area includes the project footprint plus 500 m

The local study area (LSA) is defined as the project footprint with a 500-m buffer. A 500-m buffer around the project footprint was assumed to be an adequate area to address all potential effects directly related to disturbances caused by mine activities. For example, road dust generated from within the active mine site (not including the winter roads) may potentially affect vegetation communities (*e.g.*, lichen) that are situated within a 500-m area around the footprint. Although unlikely, people may also spend time in locations closer to the Snap Lake Diamond Project plant site area while carrying out traditional activities, such as hunting, fishing and plant gathering. The LSA, which occupies an area of 1,407 hectares (ha), is also used for the assessment of impacts on terrestrial resources (Section 10). Further details on the rationale for the selection of the LSA boundary is provided in Wildlife, and ELC and Biodiversity (Sections 10.4 and 10.3) of this EA.

Figure 11.1-1 Regional Study Area for Environmental Health

Figure 11.1-2 Local Study Area for Environmental Health

The regional study area is defined as an area within a 31-km radius of the mine site

The regional study area (RSA) is defined as an area within a 31-kilometre (km) radius of the centre of the mine site. The outside boundary is situated approximately 180 km northeast of Yellowknife. The RSA was selected to assess and quantify all potential impact areas that are situated outside the LSA but may still be affected by the Snap Lake Diamond Project (*e.g.*, the winter access road and the esker access road). For example, an assessment of the potential effects on wildlife eating lichen exposed to fugitive dust in the RSA was quantified. The RSA is 301,907 ha in size. Further details on the rationale for the selection of the RSA boundary is provided in Wildlife, and ELC and Biodiversity (Sections 10.4 and 10.3) of this EA.

11.1.5 Assessment Methods

Risk assessment was the primary tool used in the impact analysis

Environmental risk assessment was the primary tool used in the impact analysis. Risk assessment was deemed necessary because it is a useful tool to determine if chemicals at a site pose a human or wildlife health risk. The risk assessment was carried out for valid linkages to evaluate whether activities associated with the Snap Lake Diamond Project might adversely impact health.

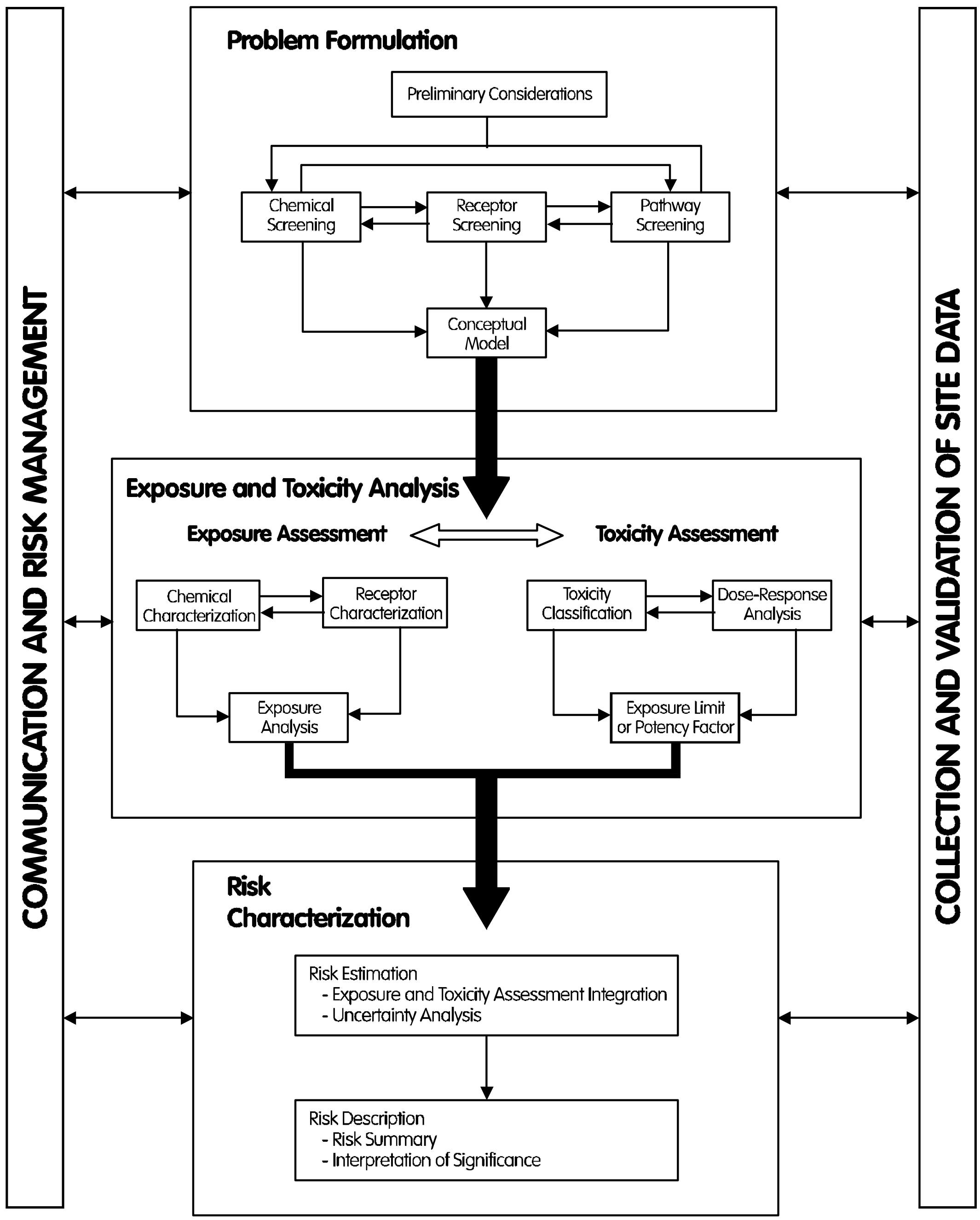
The risk assessments were conducted according to established protocols

The risk assessments were conducted according to established human and wildlife health risk assessment protocols endorsed by Health Canada, the Canadian Council of Ministers of the Environment (CCME) and the United States Environmental Protection Agency (U.S. EPA) (Health Canada 1994; CCME 1997; U.S. EPA 1996) and risk assessment principles as outlined in a report to Health Canada (Health Canada [unpublished] 1995). The process followed a widely recognized framework for environmental health risk assessment, as illustrated in Figure 11.1-3 (Health Canada [unpublished] 1995). The framework progresses from a qualitative initial phase (problem formulation), through exposure and toxicity analysis, and ends in quantitative risk characterization. The titles for these risk assessment phases appear as sub-headings in the impact analysis section in order to clearly illustrate how the risk assessment methods were applied to the impact analysis. Each of the "boxes" in Figure 11.1-3 were evaluated in the impact analysis. Details regarding risk assessment methods are presented in Appendix XI.1.

The risk assessment used in this section is different from the environmental assessments in other sections

The risk assessment method used for wildlife and human health is different from the assessments presented in other sections, but it is consistent with the Terms of Reference (MVEIRB 2001). In other sections of the EA, impacts were not defined as risks but were ranked according to a list of criteria (magnitude, frequency, duration, spatial extent, reversibility). The risk estimates derived for human and wildlife health incorporate these criteria, but in a different manner than used in other EA sections. For example, duration, frequency, and spatial extent were explicit input parameters used in the calculation of exposure to chemicals of concern. Risk estimates cannot directly be converted to environmental consequence estimates because such a conversion would involve "double-counting" of some criteria (such as spatial extent). This would produce misleading results.

Figure 11.1-3 Health Risk Assessment Framework



Source: Health Canada (unpublished) 1995.

11.2 BASELINE

11.2.1 Introduction

The baseline summarizes the existing concentrations of chemicals

The baseline section for Environmental Health (Section 11) summarizes the existing site-specific concentrations of the chemicals of concern (COC) evaluated in the wildlife health and human health impact assessments. The only approved development within the LSA or RSA is the De Beers advanced exploration program (AEP). Therefore, current sources of COCs include natural processes, localized sources within the AEP site, and long-range transport from industry in other areas of Canada and other countries.

The chemicals associated with the Snap Lake Diamond Project are metals and polycyclic aromatic hydrocarbons

The COCs associated with the Snap Lake Diamond Project are metals that are naturally occurring in the diamond-bearing kimberlite and the host rock, and polycyclic aromatic hydrocarbons (PAHs) produced by the burning of diesel by the mining fleet and power plant. The types of health impacts associated with relatively high concentrations of these COCs include respiratory illness, gastrointestinal effects, and skin irritation. Such illnesses are also associated with many influences encountered in one's life. However, the baseline health status for these types of illnesses in each of the communities that were included in this assessment is not available.

A risk assessment approach was used for the baseline assessment

The baseline assessment for human and wildlife health was conducted using a risk assessment approach. The baseline health risk assessment evaluated the effect of chemical emissions from current sources and is presented in Sections 11.3.2 and 11.3.3 for wildlife and human health, respectively. The baseline assessment was restricted to the chemicals in the environment that will have increased concentrations because of releases from the Snap Lake Diamond Project. It provides a basis for comparison with the impact assessment predictions for the Snap Lake Diamond Project (*i.e.*, application case).

Baseline risk assessments are presented within the impact assessment sections

The baseline risk assessments are presented within the impact assessment sections (11.3.1 and 11.3.2) because they could not be conducted until certain steps in the risk assessment framework common to both the baseline and application cases were complete. The logical sequence of risk assessment is best understood if it is presented in one location in this report. Therefore, this baseline section is limited to the presentation of baseline data and an explanation of how the baseline data were used.

11.2.2 Baseline Data

11.2.2.1 Air Quality

Total suspended particulate matter and dust fall were measured

Total suspended particulate (TSP) matter was measured in the LSA and RSA. TSP matter includes all microscopic airborne solid and liquid particles regardless of size (CEPA/FPAC 1998). Monitoring of TSP provides an indication of the amount of fugitive dust in ambient air.

Total suspended particulates have been monitored since April 2000

Baseline annual average air concentrations of TSP matter near the current AEP and at a site more distant from the AEP have been monitored since April 2000. Details regarding the monitoring program are presented in Section 7.2.2.2. In summary, three high volume samplers were placed around the Snap Lake AEP site to sample TSP. Two samplers were placed downwind of the crushers and mine portal (Stations A and B) and a third was placed in the vicinity of the camp (Station C). There were 21 valid samples from Station A, 16 valid samples from Station B, and 10 valid samples from Station C collected over a period of 12 months.

The annual average guideline was not exceeded at the monitoring stations

The valid 24-hour TSP concentrations observed at Snap Lake ranged from 1 to 148 micrograms per cubic metre ($\mu g/m^3$). The average 24-hour TSP concentrations at monitoring stations A, B, and C were 39 $\mu g/m^3$, 16 $\mu g/m^3$, and 7 $\mu g/m^3$, respectively. The NWT air quality guideline for annual average TSP concentration is 60 $\mu g/m^3$ and the 24-hour guideline is 120 $\mu g/m^3$. Therefore, the annual average guideline was not exceeded at any of the monitoring stations and the 24-hour average was exceeded once at Station A. TSP concentrations measured at the mine site are much lower than typically measured in Yellowknife (RWED 2001b). Refer to the Air Quality section (Section 7.2.2.2) for more details.

Sensitive people may experience respiratory symptoms when exposed to total suspended particulates

There is no available literature on the health effects of TSP on wildlife. The potential human health affects associated with TSP are primarily due to the smaller size fractions: PM_{10} (particles that are 10 microns or smaller in diameter) and $PM_{2.5}$ (particles less than 2.5 microns known as respirable particles). Sensitive individuals (*e.g.*, asthmatics, elderly, people with existing respiratory illness) may be more sensitive to ambient particulate matter than the general population. Thus, certain individuals may experience aggravated respiratory symptoms on days when particulate matter levels exceed the guidelines. The symptoms subside when particulate matter returns to regular levels. There is no evidence to suggest that particulate matter causes a more pronounced respiratory effect than other agents that cause respiratory symptoms (*e.g.*, cigarette smoke, pet dander, dust mites, pollen).

11.2.2.2 Fish Tissue Quality

Fish samples were collected in the local and regional study areas

Since some wildlife species consume fish and people consume fish fillets (muscle tissue) and liver tissues, fish samples were collected and analyzed for metals. Lake trout and round whitefish were collected from Snap Lake, MacKay Lake, and the reference lake. Collection methods and resulting data are presented in Section 9.5.

11.2.2.3 Drinking Water Quality

Snow and surface water are two sources of drinking water in the study areas

There are two types of drinking water assessed within the LSA and RSA: surface water and snow. Surface water may be used as drinking water for wildlife and for humans while hunting and fishing. The second source of drinking water is melted snow. Resident wildlife rely on snow as a source of water throughout the winter. Humans may also rely on snow as a drinking water source during winter hunting or fishing trips.

Drinking water obtained from the Snap Lake Diamond Project facilities was not evaluated

Drinking water obtained from the Snap Lake Diamond Project facilities was not included in the assessment because the project drinking water will be treated to meet drinking water quality guidelines. Since it was assumed that members of the general public would not have access to these facilities, other sources were assessed.

Surface water quality data were collected in the local and regional study areas

Baseline surface water quality data within the LSA were collected from Snap Lake. Baseline surface water quality data within the RSA were collected from MacKay Lake and the reference lake (Section 9.4).

Snow samples were collected and analyzed

In order to determine snow quality, 23 snow samples were collected within the LSA and RSA (Figure 11.2-1) in May 2001. Snow samples were melted and then filtered; the water portion and the solids portion were analyzed separately for metals and PAHs. Total snow concentrations of metals were calculated as a total of the water and solids portions.

Snow with visible dust was collected

Snow samples were also collected at the Snap Lake AEP site. These samples were collected because of community concerns that animals could eat snow that was dirty (Lutsel K'e Community visit on May 9, 2000). Therefore, sample collection was biased towards snow with visible dust, assuming that dust on snow was a source of contaminants in drinking water.

Concentrations of metals and polycyclic aromatic hydrocarbons were determined

Concentrations of metals and PAHs from the Snap Lake AEP site were included in the calculation of average snow concentrations in the LSA. However, concentrations of PAHs were less than analytical detection limits. Average concentrations of metals and PAHs in snow measured in the LSA and RSA are presented in Table 11.2-1.

Figure 11.2-1 Snow Sampling Locations

Table 11.2-1 Concentrations of Metals and Polycyclic Aromatic Hydrocarbons in Snow, May 2001

Chemicals	Mean Baseline Snow Concentration in Local Study Area (mg/L) [1]	Mean Baseline Snow Concentration in Regional Study Area (mg/L) [2]
Total Metals [3]		
Aluminum	1.0	0.0093
Antimony	0.001	0.00003
Arsenic	0.000	0.00002
Barium	0.061	0.001
Boron	0.003	0.001
Calcium	1.410	0.191
Chromium	0.123	0.099
Cobalt	0.003	0.0002
Copper	0.004	0.0001
Iron	2.438	0.005
Lead	0.043	0.008
Magnesium	3.042	0.015
Manganese	0.161	0.024
Molybdenum	0.002	0.001
Nickel	0.045	0.0003
Potassium	0.394	0.032
Sodium	0.164	0.058
Strontium	0.010	0.0005
Uranium	0.000	0.0001
Vanadium	0.003	0.0001
Zinc	0.020	0.019
Polycyclic Aromatic Hydrocarbons		
Benzo(a)anthracene	<0.10	<0.10
Benzo(a)pyrene	<0.10	<0.10
Benzo(b)fluoranthene	<0.10	<0.10
Benzo(k)fluoranthene	<0.10	<0.10
Dibenzo(a,h)anthracene	<0.10	<0.10
Indeno(1,2,3-cd)pyrene	<0.10	<0.10
Naphthalene	<0.10	<0.10
Phenanthrene	<0.10	<0.10
Pyrene	<0.10	<0.10
Quinoline	<0.10	<0.10

[1] Arithmetic mean of 9 samples; mg/L = milligram per litre.

[2] Arithmetic mean of 14 samples.

[3] Detection limits could not be reported because total snow concentrations are the sum of the water and solids portion of the snow. The detection limits from each process cannot be consolidated to provide a single detection limit for total snow concentrations.

< = less than detection limit.

Exposure to water and snow was assessed

These concentrations in surface water and snow were used to calculate the exposure to metals and PAHs for both wildlife and human health for the baseline case.

11.2.2.4 Vegetation Quality

Animals and people may consume vegetation within the study areas

Animals and people may consume vegetation within the LSA and RSA. To determine vegetation quality, twenty lichen samples were collected in June 2001 and analyzed for metals from an area within the RSA that is considered a migration route for caribou (Figure 11.2-2). PAHs were not analyzed. This is a data gap that will be addressed in further monitoring activities. Baseline lichen data were used to estimate chemical exposure through food ingestion for all herbivorous wildlife species evaluated in the impact assessment.

Concentrations of metals in lichen were used to estimate concentrations in other plant types

Although humans do not eat lichen, chemical concentrations in baseline lichen samples were used as an estimate of baseline chemical concentrations in other plant types that might be consumed by humans. Chemical concentrations in lichens were used to represent a maximum for chemical concentrations in other plant types. This is a conservative assumption because most plants take up chemicals through the roots from soil. Lichen, however, take up chemicals efficiently and readily via dust deposition. For this reason, lichen have been commonly used as an indicator species for chemical uptake in the Arctic (Richardson 1995). It would be very unlikely that other plants would accumulate higher concentrations of COCs from atmospheric deposition. This is a reasonable assumption due to the large surface area and longevity of lichens.

The mean of 20 lichen samples collected throughout the regional study area was used to represent the baseline

Lichen samples collected throughout the RSA (twenty samples in total) were used to represent baseline conditions in the LSA and RSA. Metals concentrations in lichen were calculated as an average from all sampling locations. This was done to represent a caribou or human who might be travelling through the RSA collecting vegetation from various locations. Caribou especially are exposed to average conditions throughout a large area; therefore, mean concentrations of metals in lichen are presented in Table 11.2-2. Samples were not collected from the LSA since it may not represent baseline conditions due to exploration activities.

Figure 11.2-2 Lichen Sampling Locations

Table 11.2-2 Concentrations of Metals in Lichen, June 2001

Chemical	Mean Baseline Concentration[a] (mg/kg)[b]	Detection Limit (mg/kg)
Aluminum	937	4
Antimony	<0.04	0.04
Arsenic	0.29	0.2
Barium	41.77	0.08
Beryllium	<0.2	0.2
Cadmium	<0.08	0.08
Calcium	2189	10
Chromium	8.56	0.2
Cobalt	0.49	0.08
Copper	2.46	0.08
Iron	507	2
Lead	1.06	0.04
Magnesium	505	2
Manganese	118	0.04
Mercury	0.06	0.01
Molybdenum	0.36	0.04
Nickel	5.14	0.08
Phosphorus	375	2
Potassium	1464	2
Selenium	<0.2	0.2
Silver	<0.08	0.08
Sodium	326	2
Strontium	12	0.04
Thallium	<0.04	0.04
Tin	<0.08	0.08
Titanium	36	0.05
Vanadium	1.22	0.08
Zinc	26	0.2

< = less than detection limit.
[a] Arithmetic mean of twenty samples that were collected in the regional study area.
[b] mg/kg = milligram per kilogram.

11.2.2.5 Soil Quality

The mean of 20 soil samples collected in the regional study area was used to represent the baseline

People and wildlife inadvertently consume soil every day because soil adheres to food, because of hand-to-mouth transfer (humans) or through grooming activities (wildlife). Twenty soil samples were collected in the RSA and were analyzed for metals and PAHs in June 2001. Samples were collected in areas similar to areas where vegetation was collected (Figure 11.2-3). Concentrations of metals and PAHs in soil collected in the RSA are expected to represent baseline concentrations. Samples were not collected in the LSA for the same reason presented above for vegetation. Mean concentrations of metals and PAHs were calculated to represent the average exposure by wildlife and humans. Mean concentrations of metals and PAHs in soil are presented in Table 11.2-3.

Figure 11.2-3 Soil Sampling Locations

Table 11.2-3 Concentrations of Metals and Polycyclic Aromatic Hydrocarbons in Soil, June 2001

Chemical	Mean Baseline Soil Concentration[a] (mg/kg)[b]	Detection Limit (mg/kg)
Metals		
Aluminum	9976	10
Antimony	<0.1	0.1
Arsenic	1.4	0.1
Barium	80.2	0.5
Beryllium	<1	1
Cadmium	<0.5	0.5
Calcium	1719	100
Chromium	43.4	0.5
Cobalt	5.9	1
Copper	21.5	1
Iron	12524	100
Lead	<5	5
Magnesium	4438	10
Manganese	109	20
Mercury	0.05	0.01
Molybdenum	1.8	1
Nickel	21.8	2
Phosphorus	396	10
Potassium	2182	20
Selenium	0.1	0.1
Silver	<1	1
Sodium	271	100
Strontium	15.10	1
Thallium	<1	1
Tin	<5	5
Titanium	635	5
Vanadium	31	1
Zinc	38.7	0.5
Polycyclic Aromatic Hydrocarbons		
Benzo(a)anthracene	<0.05	0.05
Benzo(a)pyrene	<0.05	0.05
Benzo(b)fluoranthene	<0.05	0.05
Benzo(k)fluoranthene	<0.05	0.05
Dibenzo(a,h)anthracene	<0.05	0.05
Indeno(1,2,3-cd)pyrene	<0.05	0.05
Naphthalene	0.07	0.05
Pyrene	<0.05	0.05
Quinoline	<0.05	0.05

< = less than detection limit.

[a] Arithmetic mean of twenty samples that were collected in the regional study area.

[b] mg/kg = milligram per kilogram.

11.3 IMPACT ANALYSIS

11.3.1 Introduction

Two key questions were developed based upon issues identified through the Terms of Reference and traditional knowledge

Two key questions were developed to address issues identified in the Terms of Reference for the Snap Lake Diamond Project and traditional knowledge (Sections 11.1.1 and 11.1.3). The two key questions developed for this assessment include the following:

Key Question EH-1: What impacts will the Snap Lake Diamond Project have on wildlife health?

Key Question EH-2: What impacts will the Snap Lake Diamond Project have on human health?

Assessment method involves seven steps that lead to the risk assessment and monitoring of impacts

The assessment method undertaken included the following steps:

- collect baseline information relevant to the key questions;
- develop linkage diagrams;
- analyze linkages using a risk assessment approach;
- describe appropriate activities that will mitigate impacts;
- analyze impacts by using exposure and toxicity assessments to characterize risk;
- classify all risks; and,
- provide recommendations on monitoring programs, if necessary.

A risk assessment approach was used to evaluate wildlife and human health

The wildlife and human health impact assessment evaluates potential risks to wildlife valued ecosystem components (VECs) and humans as a result of chemical emissions from existing sources and the Snap Lake Diamond Project. A risk assessment approach was used for the evaluation. Detailed risk assessment methods are presented in Appendix XI.1.

11.3.2 Key Question EH-1: What Impacts Will the Snap Lake Diamond Project Have on Wildlife Health?

11.3.2.1 Linkage Analysis

The linkage analysis includes problem formulation

The linkage analysis step of the wildlife health impact assessment follows several steps according to risk assessment methods. Prior to analysis of the potential linkages, a problem formulation step is conducted. Problem formulation defines receptors (*i.e.,* wildlife VECs or other species with the greatest potential for exposure to chemical emissions from the Snap Lake Diamond Project), the chemicals of concern, and the pathways by which wildlife may be exposed. Following the problem formulation step, the linkage analysis is conducted.

11.3.2.1.1 Problem Formulation

Receptor Selection

The wildlife receptors evaluated in this assessment include the following:

- caribou (Bathurst herd);
- grizzly bear;
- wolf;
- fox (red and Arctic);
- wolverine;
- peregrine falcon;
- willow ptarmigan;
- Arctic ground squirrel;
- common loon;
- mallard duck; and,
- semi-palmated plover.

The receptors are representatives of the food chain

The receptors listed above are representative of the species that would be found in different positions in the food chain (*e.g.*, plant-eating and meat-eating species). Due to the conservative assumptions used throughout the risk assessment (see Appendix XI.1), it is expected that other wildlife species would not be exposed to greater concentrations than evaluated for the species listed above. Furthermore, the receptors represent a potentially wide range of sensitivity to chemicals because species from several different mammalian and avian families are included.

The receptors evaluated in the health assessment were selected from the wildlife component

The receptors for the wildlife health assessment were selected from the list of wildlife VECs for the Snap Lake Diamond Project. These VECs were screened and selected by the wildlife assessment team and include species that are valued by people that use the LSA and RSA for hunting purposes (*e.g.*, caribou and ptarmigan) and those that are prey species for other wildlife (*e.g.*, Arctic ground squirrel). The rationale for the selection of VECs is presented in Section 10.1.5.4.

The Arctic ground squirrel was also selected as a receptor because it is a common prey species

Although not a VEC for the wildlife impact assessment, the Arctic ground squirrel (*Spermophilus parryii*) was added to the list of receptors for the wildlife health assessment because it is a representative of an important prey item for grizzly bears, wolves, and raptors. Some individuals would have potentially higher exposure to chemicals from the Snap Lake Diamond Project due to the Arctic ground squirrel's small home range relative to the other wildlife receptors. The Arctic ground squirrel was added to represent other species, such as lemmings, that are also prey items for carnivores including raptors.

Chemicals of Concern

The predicted chemical concentrations were screened

The predicted chemical concentrations for the application case were screened to determine the chemicals of concern for the wildlife health assessment. The chemical screening followed a step-wise process, as discussed in the following paragraphs.

Comparing application concentrations to baseline concentrations was the first step

First, chemical concentrations for the application case (*i.e.*, concentrations from the project plus baseline concentrations) were screened against baseline chemical concentrations. If the incremental increase in chemical concentrations between baseline and application cases was less than 5%, these chemicals were eliminated from further consideration in the wildlife health assessment because the incremental increase would be too low to produce a toxic response in wildlife. An increase of 5% was used because 5% is within laboratory analytical error. Conversely, chemicals with incremental increases above 5% were carried forward in the chemical screening process to the next step.

Chemicals were also compared to media- specific criteria

In the second step, chemicals were compared to media specific criteria for the protection of wildlife, if available (*e.g.*, soil quality guidelines, water quality guidelines). Chemicals that exceeded these criteria were carried forward in the chemical screening process to the next step. Criteria were not available for some chemicals. These chemicals were automatically carried forward in the chemical screening process to the next step.

Essential nutrients and inert chemicals were removed from the list

In the final step, the remaining chemicals were evaluated with respect to potential toxicity. Essential nutrients and inert chemicals were removed from the chemical list, since these chemicals would not produce a toxic response in wildlife. All remaining chemicals were evaluated in the wildlife health assessment. A detailed description of chemical screening process is presented in Appendix XI.1.

Seven chemicals of concern were evaluated in the wildlife health impact assessment

The chemical screening process produced the following chemicals of concern:

- aluminum;
- barium;
- chromium;
- manganese;
- strontium;
- thallium; and,
- naphthalene.

Barium, manganese and strontium were evaluated for the post-closure case.

Exposure Pathways

Exposure pathways are the routes by which wildlife may be exposed

Exposure pathways are the routes by which wildlife may be exposed to chemicals. They form the basis for the linkages that are evaluated in the impact assessment. A pictorial representation of the wildlife exposure pathways is presented in Figure 11.3-1. Exposure pathways are explained in detail in Appendix XI.1.

11.3.2.1.2 Linkage Analysis

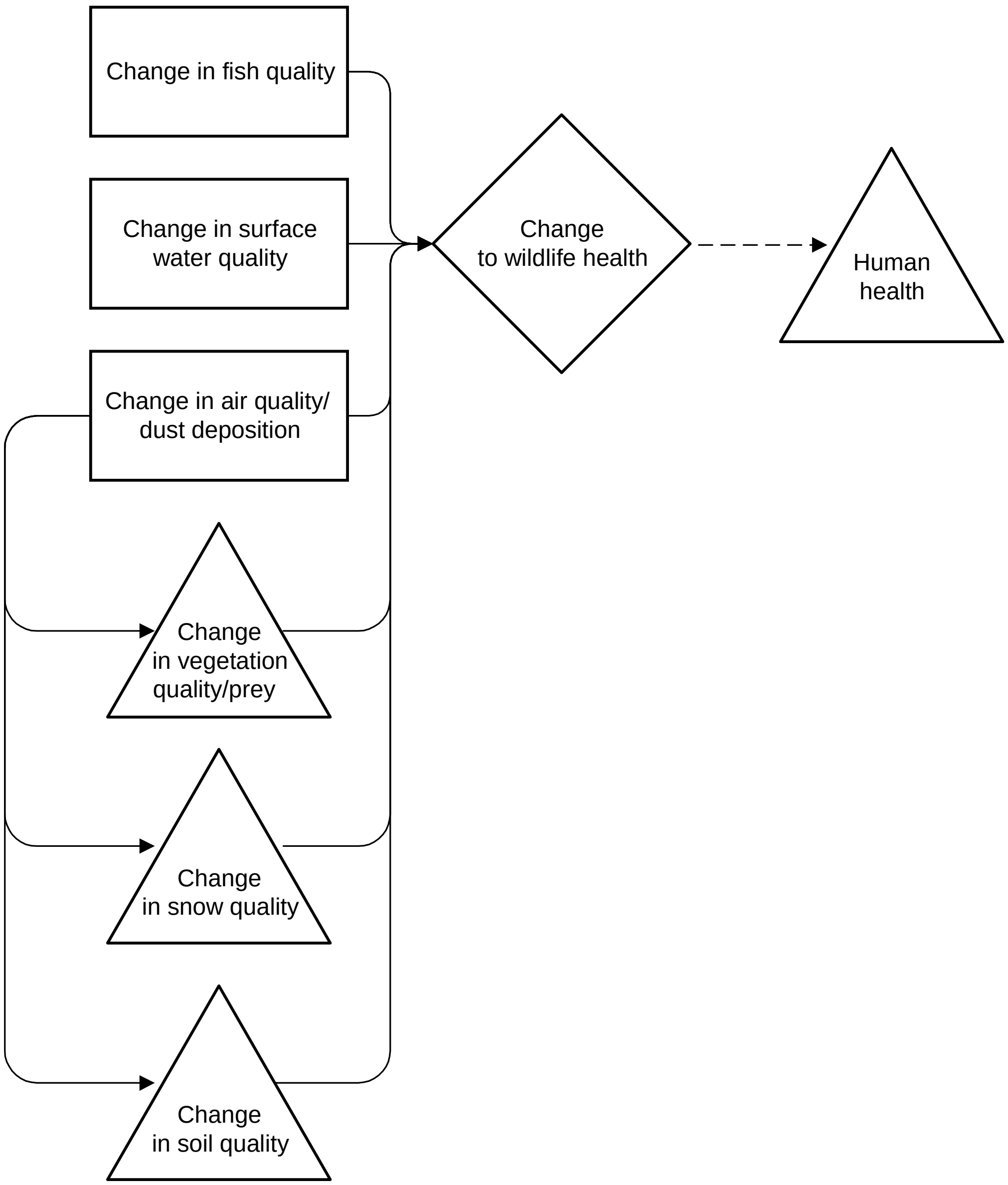
Linkages between emissions and wildlife health were evaluated

The potential linkages between the Snap Lake Diamond Project and wildlife health were evaluated to answer Key Question EH-1 (Figure 11.3-2). The following five linkages were analyzed:

- linkage between changes in air quality and wildlife health;
- linkage between changes in soil quality and wildlife health;
- linkage between changes in water and snow quality and wildlife health;
- linkage between changes in fish quality and wildlife health; and,
- linkage between changes in plant/prey tissue quality and wildlife health.

Figure 11.3-1 Wildlife Exposure Pathways

Figure 11.3-2 Wildlife Health Linkage Diagram



All wildlife receptors may be exposed to airborne chemicals through inhalation; therefore, this linkage is valid

All wildlife receptors within the LSA and RSA may be exposed to airborne chemicals that will be emitted by the Snap Lake Diamond Project by direct inhalation of fugitive dust. Fugitive dust may include metals and PAHs attached to dust particles. The handling of kimberlite is the major source contributing to metals in fugitive dust, while incomplete combustion of fuel from vehicle exhaust and other power sources contributes to PAHs in fugitive dust. This linkage is valid and was evaluated in the impact assessment for the operation phase. Air emissions will cease following closure and, therefore, effects on wildlife health via this linkage will not occur after closure.

Wildlife inadvertently ingest soil while feeding; therefore, the linkage to soil is valid for the operation phase

Fugitive dust emitted from the Snap Lake Diamond Project may deposit onto soil. The dust may be composed of metals and PAHs. Wildlife within the LSA and RSA may be exposed to metals and PAHs in soil since most wildlife inadvertently ingest soil while feeding (Beyer *et al.* 1994). This linkage is valid for all species; therefore, ingestion of metals and PAHs from soil was evaluated in the impact assessment for the operation phase. Dust emissions will cease following closure, thereby eliminating effects on soil chemistry during post-closure.

Snow is a source of drinking water; therefore, the linkage to snow is valid for the operation phase

Fugitive dust emitted from the Snap Lake Diamond Project may deposit onto snow. Wildlife in the LSA and RSA may use snow as a source of drinking water during winter. This linkage is valid only for wildlife species living in the LSA and RSA during winter (*i.e.*, caribou, wolverine, wolf, and fox). Therefore, the linkage is valid and ingestion of metals and PAHs in snow was evaluated in the impact assessment for the operation phase. Dust emissions will cease following closure. Therefore, impacts via ingestion of snow will not occur after closure.

Drainage ditches and sedimentation ponds may provide drinking water during mine operation

Another source of drinking water within the LSA may be standing water on-site including drainage ditches around the north pile, collection ponds, sumps and the water management pond. Metals that have leached from the waste rock may deposit within these ponds. For the purposes of this assessment it was assumed that wildlife will have access to these on-site water sources (*i.e.*, some are not fenced). This linkage is valid for caribou, grizzly bears, wolves, foxes, wolverines, and Arctic ground squirrels and was evaluated in the impact assessment for the operation phase. The sedimentation ponds and drainage ditches will be remediated during closure (Section 2.5.1.3 in the Decommissioning and Reclamation Plan [Appendix III.11]); therefore, impacts to wildlife via this linkage will not occur after closure.

The surface water quality linkage is valid for both operation and closure

Water quality may change in Snap Lake during the operation of the Snap Lake Diamond Project. In addition, during post-closure, water quality may be impacted in the north lake. Thus, impacts to wildlife due to ingestion of water from lakes are possible. Therefore, the surface water linkage was evaluated in the assessment for the application (Snap Lake) and post-closure (north lake) cases.

Fish compose approximately 100% of the loon diet

Fish compose approximately 100% of the loon diet. Since fish can take up chemicals from water, loons may also be exposed to chemicals from fish.

Therefore, this linkage is valid for fish-eating birds and was evaluated in the impact assessment for the application (Snap Lake) and post-closure (north lake) cases.

Wildlife may be exposed to metals and polycyclic aromatic hydrocarbons by ingesting plants; therefore, this linkage is valid for herbivores

The Snap Lake Diamond Project will potentially emit fugitive dust from its activities. Dust from the site containing metals and PAHs may deposit directly onto the surface of plants or may deposit onto soils and be subsequently taken up through plant roots. Wildlife may be exposed to metals and PAHs by ingesting plants within the LSA and RSA. This linkage is valid for animals that eat plants (*i.e.*, caribou, grizzly bear, ptarmigan, and Arctic ground squirrel). Therefore, the linkage is valid and ingestion of metals and PAHs from plants was evaluated in the impact assessment for these receptors for the operation phase. Exposure by this linkage to wildlife health will not occur after closure since airborne emissions will cease when the mine is closed.

Wildlife may be exposed to metals and polycyclic aromatic hydrocarbons by ingesting prey; therefore, this linkage is valid for carnivores

Some of the wildlife species evaluated in the risk assessment are carnivores. These species may be exposed to chemicals in their prey if their prey have consumed impacted water, soil, or vegetation. This linkage is valid only for wildlife species in the LSA/RSA that are carnivorous (*i.e.*, grizzly bear, wolverine, wolf, fox, and peregrine falcons). Therefore, the linkage was evaluated in the impact assessment for these receptors for the operation phase. Exposure by this linkage to wildlife health will not occur after closure since airborne emissions will cease when the mine is closed.

All exposure pathways evaluated for the operation phase (the application case) were evaluated for the baseline case.

11.3.2.2 Mitigation

Mitigation for air and water quality is protective of wildlife health

Mitigation for emissions that may impact wildlife health are defined in Section 7.4 (air quality section) and Section 9.4 (water quality section). Mitigation for air and water quality is protective of wildlife health because concentrations of chemicals of concern are reduced by mitigation in all exposure pathways.

11.3.2.3 Impact Analysis

Exposure and toxicity assessments are used to characterize risk

The impact analysis includes the following:

- **Exposure assessment** estimates the amount of a chemical a receptor may take into its body through all applicable exposure pathways;

- **Toxicity assessment** defines the toxicity of the chemicals of concern and the chemical dose at which toxic effects may begin to occur in wildlife receptors; and,
- **Risk characterization** compares the amount of exposure predicted for each receptor (exposure assessment) to the chemical dose at which toxic effects may begin to occur in wildlife receptors (toxicity assessment).

11.3.2.3.1 Exposure Assessment

This assessment determines the amount of exposure

The exposure assessment is a process for determining the amount of each chemical to which each receptor is likely to be exposed within the LSA and RSA when the Snap Lake Diamond Project is in operation.

Temporal and spatial boundaries are required to estimate exposure

Temporal and spatial boundaries are required to define the geographic area that each receptor is likely to inhabit and where each receptor is likely to be exposed to chemicals from the Snap Lake Diamond Project.

11.3.2.3.2 Temporal and Spatial Boundaries

The wildlife health assessment uses the timeline of 25 years for the application case

The wildlife health exposure assessment uses the timeline for the application case of the Snap Lake Diamond Project which includes construction, operation, and closure (*i.e.*, the total time that a substantial amount of activity is occurring at the site). Therefore, the wildlife health assessment uses a project duration of 25 years.

Exposure to the north lake water will be evaluated for the post-closure case

Airborne emissions will cease after closure of the Snap Lake Diamond Project. On-site ponds will be remediated; however, groundwater from the mine area may seep into lakes to the north of Snap Lake (identified as the north lake and the northeast lake). Water quality in these lakes may be altered. Therefore, impacts to wildlife health were evaluated for exposure to water in the north lake during post-closure.

Receptors with small home ranges may live entirely within the local study area

The amount of time each receptor was assumed to spend within the LSA and/or RSA was based on the home range of the receptor compared to the size of the LSA and RSA. For receptors with small home ranges (*i.e.*, Arctic ground squirrel, ptarmigan, fox), the area of the LSA was often equal to or greater than the home range of these receptors. Therefore, these receptors were assumed to receive 100% exposure from soil, vegetation, and/or prey from the LSA (Table 11.3-1).

Table 11.3-1 Number of Days per Year that Wildlife Receptors May be Present in the LSA and RSA

Valued Ecosystem Component	Time Spent in LSA (days per year)	Time Spent in RSA (days per year)
Animals with Small Home Ranges		
Fox	365	365
Ptarmigan	365	365
Arctic ground squirrel	365	365
Animals with Large Home Ranges		
Grizzly	2	242
Wolf	2	181
Wolverine	2	363
Migratory Animals		
Caribou	1	182
Peregrine falcon	1	152
Waterfowl and shorebirds	124	124

Receptors with large home ranges may spend a proportionate period of time in the local and regional study areas

For receptors that have large home ranges (*i.e.*, grizzly bear, wolves, wolverine), the area of the LSA was much less than the areas of the home ranges. Therefore, for these receptors, the amounts of time spent within the LSA and RSA were proportional to the fraction of the home range occupied by the LSA and RSA (Table 11.3-1). For example, the home range of a grizzly bear is 207,400 to 668, 500 ha (McLoughlin *et al.* 1999). The areas of the LSA and RSA are 1,407 ha and 301,907, respectively. Therefore, the LSA would constitute less than 1% of a grizzly bear home range. The RSA would constitute the remaining 99% of the grizzly bear home range. Therefore, the grizzly bear was assumed to spend 1% of its time feeding within the LSA and 99% of its time feeding within the RSA.

Grizzly bears were evaluated for the time of the year that they are active

Since grizzly bears are not active during the winter months, the number of days that grizzly bears may be exposed to the chemicals of concern is equivalent to the number of days, on average, that they are active during the year.

The time that migratory animals may be within the local and regional study areas was based on observation of these animals by the wildlife assessment team

Caribou and peregrine falcons are migratory animals. Loons, mallard ducks and semi-palmated plovers are also migratory but could potentially inhabit a waterbody for the whole period that they are in the north. The time that migratory animals may be within the LSA and RSA was based on observation of these animals by the wildlife assessment team (Section 10.4). The amount of time spent in the LSA versus the RSA was expressed as a fraction of the areas of the LSA and RSA (Table 11.3-1).

11.3.2.3.3 Receptor Exposure Parameters

Exposure parameters were gathered from published literature

For each receptor, information on typical diets, body weights, ingestion rates, and inhalation rates were gathered from the published scientific literature (U.S. EPA 1993; Beyer *et al.* 1994; Dunning 1993; BC MELP 1996; Environment Canada 2000; RWED 2001a; Kroner and Cozzie 1999; Silva and Dunning 1995). Receptor exposure parameters are presented in Appendix XI.1.

11.3.2.3.4 Exposure Estimates

Concentrations of metals and polycyclic aromatic hydrocarbons were predicted for the application case

Concentrations of metals and PAHs were predicted for each exposure medium for the application case. Air quality and water quality predictions are presented in Sections 7.3 and 9.4, respectively. Predictions of concentrations of metals and PAHs in soil, vegetation, prey, and snow are presented in Appendix XI.1. The average predicted concentrations were used because, in most cases, deposition of metals and PAHs would be expected to be patchy and emission rates and weather conditions correlated with deposition rates would be highly variable. Therefore, the distribution of metals and PAH concentrations across the LSA or RSA would not be expected to be uniformly high.

Exposures via each pathway were added

Exposures to the chemicals of concern for each exposure pathway were added to determine the total exposure for each receptor.

11.3.2.3.5 Toxicity Assessment

Toxicity assessment involves identification of the potentially toxic effects

Toxicity assessment involves identification of the potentially toxic effects of the chemicals of concern and determination of the chemical dose at which toxic effects may occur in wildlife receptors. This is referred to as the benchmark dose.

Benchmark doses were derived from laboratory studies

Benchmark doses were derived from the lowest observed adverse effect levels (LOAEL) for laboratory test species. These are the lowest doses in laboratory studies that had an effect on the test animals (*i.e.*, reduced growth; reduced reproduction; blood chemistry changes). Since laboratory studies often use mice and rats, the LOAELs were extrapolated to the wildlife receptors using the allometric models for interspecies extrapolation (Sample and Arenal 1999). No observed adverse effect levels (NOAELs) were used when LOAELs were not available or not appropriate (*i.e.*, included mortality as an endpoint). The peer-reviewed compilation of wildlife toxicity benchmarks (Sample *et al.* 1996) was used as the primary source of toxicity information (refer to Appendix XI.1 for more details).

11.3.2.3.6 Risk Characterization

The final step involves comparison of the exposure estimate to the toxicity benchmark

The final step of the risk assessment involves comparison of the exposure estimate to the toxicity benchmark. The product of this comparison is called an exposure ratio (ER). The ER was calculated using the following equation:

$$ER = \frac{\text{estimated exposure}}{\text{toxicity benchmark}}$$

Exposure ratios less than one indicate no impacts to wildlife health

ERs are a measure of the magnitude of the potential adverse effect to individual animals associated with exposure to chemicals emitted from the Snap Lake Diamond Project. ERs less than 1 indicate that there are no risks/impacts to wildlife health from the predicted exposures to the COC. An ER greater than 1 indicates that there is a potential for effects on some individuals. Tables 11.3-2 and 11.3-3 present the ERs for each receptor and chemical of concern for the baseline and application cases in the LSA and RSA.

All exposure ratios are similar between baseline and application cases and all exposure ratios are less than 1 except for exposure to aluminum

All ERs are similar between baseline and application cases and all ERs are less than 1 except for exposure to aluminum. ERs were greater than 1 for aluminum exposure to caribou, grizzly bear, wolverine, Arctic ground squirrel, and ptarmigan for both the baseline and application cases (Table 11.3-2 and Table 11.3-3).

The baseline concentration of aluminum in soil was the main contributor to exposure

The main source of aluminum exposure is via soil ingestion, and the baseline aluminum concentration was the main contributor to exposure. Baseline soil concentrations were 9976 milligrams per kilogram (mg/kg). This is associated with the natural presence of aluminum. This is within the range to background concentrations in other regions where they have been reported to be between 4,300 to 82,000 mg/kg (RAIS 2002).

The exposure ratios for aluminum are likely over-estimated

The risk assessment assumed that 100% of the aluminum in soil was available for uptake in wildlife. However, most naturally occurring aluminum compounds are insoluble and, therefore, not available for uptake in wildlife (Pais and Jones 1997). The amount of aluminum that would be available in soil is based on soil-specific conditions such as organic content, cation-exchange capacity, pH, and the presence of other metals (Kabata-Pendias and Pendias 1992). An availability of less than 100% cannot be assumed without this site-specific information. Therefore, although ERs greater than 1 were calculated, the risk is likely over-estimated. Health effects from aluminum that is predominantly naturally occurring are not expected in wildlife in the LSA and RSA.

Table 11.3-2 Exposure Ratios for the Baseline and Application Cases for Wildlife that Inhabit Both the Local Study Area and Regional Study Area

Metals	Baseline	Application
Caribou		
Aluminum	1.4	1.4
Barium	0.2	0.2
Chromium	0.00007	0.0001
Manganese	0.009	0.01
Strontium	0.001	0.001
Thallium	0.009	0.01
Naphthalene	0.00000007	0.00005
Grizzly Bear		
Aluminum	1.6	1.9
Barium	0.2	0.2
Chromium	0.00007	0.00009
Manganese	0.008	0.01
Strontium	0.0009	0.001
Thallium	0.01	0.01
Naphthalene	0.0000002	0.00005
Wolf		
Aluminum	0.4	0.4
Barium	0.01	0.01
Chromium	0.00001	0.00001
Manganese	0.0002	0.0002
Strontium	0.00004	0.00004
Thallium	0.004	0.005
Naphthalene	0.00000009	0.0000009
Wolverine		
Aluminum	1.2	1.2
Barium	0.03	0.03
Chromium	0.00003	0.00003
Manganese	0.0008	0.0008
Strontium	0.0001	0.0001
Thallium	0.01	0.01
Naphthalene	0.0000003	0.000003
Peregrine Falcon		
Aluminum	0.04	0.04
Barium	0.00009	0.00009
Chromium	0.0006	0.006
Manganese	0.00004	0.00004
Strontium	- [1]	- [1]
Thallium	- [1]	- [1]
Naphthalene	- [1]	- [1]

[1] Could not be calculated due to a lack of avian-specific toxicity information.

Table 11.3-3 Exposure Ratios for the Baseline and Application Cases for Wildlife that Live Entirely within the Local Study Area or Regional Study Area

Chemicals	Local Study Area		Regional Study Area	
	Baseline	Application	Baseline	Application
Fox				
Aluminum	0.6	0.7	0.6	0.6
Barium	0.02	0.02	0.02	0.02
Chromium	0.00002	0.00002	0.00002	0.00002
Manganese	0.0004	0.0006	0.0004	0.0004
Strontium	0.00006	0.0005	0.00006	0.00006
Thallium	0.007	0.009	0.008	0.008
Naphthalene	0.0000002	0.00002	0.0000002	0.000001
Arctic Ground Squirrel				
Aluminum	6.3	7.7	6.3	7.7
Barium	0.7	0.9	0.7	0.9
Chromium	0.0003	0.0004	0.0003	0.0004
Manganese	0.03	0.04	0.03	0.04
Strontium	0.004	0.005	0.004	0.004
Thallium	0.04	0.06	0.04	0.06
Naphthalene	0.0000005	0.004	0.0000005	0.0002
Ptarmigan				
Aluminum	0.9	1.0	0.9	1.0
Barium	0.1	0.2	0.1	0.2
Chromium	0.2	0.3	0.2	0.2
Manganese	0.006	0.008	0.006	0.008
Strontium	-[1]	-[1]	-[1]	-[1]
Thallium	-[1]	-[1]	-[1]	-[1]
Naphthalene	-[1]	-[1]	-[1]	-[1]
Mallard Duck				
Aluminum	0.06	0.2	0.04	0.04
Barium	0.001	0.002	0.001	0.002
Chromium	0.009	0.02	0.005	0.005
Manganese	0.00005	0.0001	0.00004	0.00004
Strontium	-[1]	-[1]	-[1]	-[1]
Thallium	-[1]	-[1]	-[1]	-[1]
Naphthalene	-[1]	-[1]	-[1]	-[1]
Common Loon				
Aluminum	0.0008	0.007	0.0009	0.0009
Barium	0.00004	0.005	0.00005	0.00005
Chromium	0.0003	0.002	0.0005	0.0005
Manganese	0.000006	0.00005	0.000004	0.000004
Strontium	-[1]	-[1]	-[1]	-[1]
Thallium	-[1]	-[1]	-[1]	-[1]
Naphthalene	-[1]	-[1]	-[1]	-[1]

Table 11.3-3 Exposure Ratios for the Baseline and Application Cases for Wildlife that Live Entirely within the Local Study Area or Regional Study Area (continued)

Chemicals	Local Study Area		Regional Study Area	
	Baseline	Application	Baseline	Application
Semi-palmated Plover				
Aluminum	0.9	0.8	0.8	0.8
Barium	0.03	0.03	0.03	0.03
Chromium	0.1	0.1	0.1	0.1
Manganese	0.0008	0.0008	0.0008	0.0008
Strontium	- [1]	- [1]	- [1]	- [1]
Thallium	- [1]	- [1]	- [1]	- [1]
Naphthalene	- [1]	- [1]	- [1]	- [1]

[1] Could not be calculated due to a lack of avian-specific toxicity information.

Direct and indirect exposure to chemicals emitted from the Snap Lake Diamond Project will not result in adverse wildlife health impacts

Direct exposure (*i.e.*, inhalation of dust, drinking water, eating soil and vegetation) and indirect exposure (*i.e.*, ingesting prey) to chemicals emitted from the Snap Lake Diamond Project will not result in adverse wildlife health impacts. Due to the conservative nature of the risk assessment, there is a high degree of confidence that wildlife would not be exposed to chemical concentrations in their environment that would present a health risk.

No adverse wildlife health effects are predicted post-closure

ERs for the post-closure case are presented in Table 11.3-4. All ERs are substantially less than 1. Therefore, health risks are not expected to occur in wildlife exposed to water in the north lake.

Table 11.3-4 Exposure Ratios for the Post-Closure Case for Wildlife that Could be Exposed to Water in the North Lake

Wildlife Receptor	Barium	Manganese	Strontium
Caribou	0.0000009	0.000000003	0.0000002
Grizzly bear	0.0000009	0.000000002	0.0000002
Wolverine	0.000001	0.00000003	0.0000002
Fox	0.0002	0.0000005	0.00004
Arctic ground squirrel	0.0001	0.0000004	0.00003
Ptarmigan	0.00002	0.00000007	0.00003
Peregrine falcon	0.0000001	0.0000000004	0.0000001
Mallard duck	0.00005	- [1]	- [1]
Common loon	0.0005	- [1]	- [1]
Semi-palmated plover	0.00006	- [1]	- [1]

[1] Could not be calculated due to a lack of avian-specific toxicity information.

11.3.2.4 Residual Impact Classification

The risk estimates stand alone as integrated expressions of potential for effects on wildlife health

As explained in Section 11.1.5, the risk assessment method used for wildlife health is different from that presented in other sections. Risk estimates incorporate the impact criteria used in other sections, but in a different manner. Therefore, risk estimates cannot directly be converted to environmental consequence estimates. Instead, the risk estimates stand alone as integrated expressions of potential for effects on wildlife health.

Health risks to wildlife are not expected

All ERs are similar between the baseline and application cases, and all ERs are less than 1 except for exposure to aluminum. ERs were greater than 1 for aluminum exposure to caribou, grizzly bear, wolverine, Arctic ground squirrel, and ptarmigan for both the baseline and application cases. This is due to naturally present, but likely unavailable, aluminum in soil. For the post-closure case, all ERs are substantially less than 1. Wildlife health risks are not expected to occur in wildlife for both application and closure cases.

11.3.2.5 Mitigation and Monitoring

De Beers will conduct further soil characterization and analysis to reduce the uncertainty associated with the availability of aluminum from soil

ERs greater than 1 were calculated for exposure to aluminum for both the baseline and application cases. This exposure is mainly due to the aluminum that is naturally present in the soil; the incremental increase over the baseline case due to the Snap Lake Diamond Project is small. It is also likely that aluminum ERs are over-estimated since it was assumed that the naturally present aluminum is 100% available for uptake by wildlife. In order to reduce the uncertainty associated with baseline exposure, particularly aluminum availability, De Beers will conduct further soil characterization and analysis. Annual soil monitoring is not necessary because the incremental increase in chemical concentrations due to the Snap Lake Diamond Project is predicted to be small. However, limited sampling will be conducted to confirm this prediction.

Additional mitigation measures are not recommended; planned air and water monitoring will be sufficient

Since impacts to wildlife health are not predicted, additional mitigation measures beyond the air quality, soil quality, and water quality mitigation measures already planned and committed to are not recommended. Air quality and water quality monitoring programs are discussed in Sections 7.4 and 9.4, respectively. A limited soil sampling program is described above. These programs will be sufficient for confirming predictions of effects on wildlife health, since air and water are the original sources leading to all exposure pathways.

11.3.3 Key Question EH-2: What Impacts Will the Snap Lake Diamond Project Have on Human Health?

11.3.3.1 Linkage Analysis

The linkage analysis includes problem formulation

The linkage analysis step of the human health impact assessment follows several steps according to risk assessment methods. Prior to analysis of the potential linkages, a problem formulation step must occur. The problem formulation defines the objectives and scope of the assessment. It includes the definitions of the receptors (*i.e.*, people with the greatest potential for exposure to chemical emissions from the Snap Lake Diamond Project), the chemicals of concern, and the pathways by which humans may be exposed. Following the problem formulation step, the linkage analysis is conducted.

11.3.3.1.1 Problem Formulation

Receptor Selection

The human health assessment addresses non-occupational exposure

The human health assessment addresses non-occupational, involuntary exposure to chemicals released by the Snap Lake Diamond Project. The health and safety of on-site employees is protected by occupational health and safety regulations, and was not evaluated in this assessment. The health and safety regulations are protective of employees at all times while on the site. Employees will not be permitted to fish or harvest game during work periods.

People who hunt in the local and regional study areas and their families were evaluated

The most likely type of non-occupational exposure would be the exposure of people who travel to the study area to harvest traditional foods (*i.e.*, game, fish, and vegetation). People who hunt and fish in the area could be exposed directly to chemicals from the Snap Lake Diamond Project in air, water, snow, and soil. Vegetation and wildlife may accumulate chemicals from the Snap Lake Diamond Project; therefore, indirect exposure to people that hunt and fish may occur through consumption of traditional foods. Family and other community members may be indirectly exposed to chemicals from the Snap Lake Diamond Project because traditional foods (*e.g.*, caribou meat) could be brought back to communities for consumption.

Each life phase was evaluated

Each life phase (*i.e.*, toddler life phase = age 7 months to 4 years; child life phase = age 5 to 11 years; adult life phase = age 20 to 70) was evaluated throughout the risk assessment because exposure rates and sensitivity to chemicals may vary for each life phase. The risk assessment is protective of the entire family because the most conservative consumption rates for each life phase were used in the risk assessment. The adolescent life phase (12-19 years) was not specifically evaluated, but would be similar to the child life phase.

Chemicals of Concern

Concentrations of metals and polycyclic aromatic hydrocarbons were predicted for each exposure pathway

A detailed description of the chemical screening process is presented in Appendix XI.1. In summary, concentrations of metals and PAHs were predicted for each exposure pathway for the application case. Baseline data were collected for concentrations of metals and PAHs in snow, plants, soil, and water. Measured and predicted concentrations of metals and PAHs were compared with regulatory guidelines.

Nitrogen oxide, sulphur dioxide, and particulate matter were evaluated

In addition to exposure to metals and PAHs, airborne chemicals such as nitrogen oxide (NO_2), sulphur dioxide (SO_2), and particulate matter which may be associated with human illnesses such as asthma, were evaluated. Particulate matter, NO_2, and SO_2 concentrations were predicted for the application case and compared to applicable regulatory guidelines.

The only chemical of concern that was quantitatively evaluated in the impact assessment is naphthalene

The only COC that was quantitatively evaluated in the impact assessment is naphthalene because this is the only chemical that exceeded predicted baseline concentrations and because there are no guidelines established to protect human health. Naphthalene was evaluated in the human health impact assessment for all exposure pathways, except drinking water from Snap Lake and the north lake (post-closure case) since naphthalene is not predicted to be present in waterbodies near the Snap Lake Diamond Project. No metals were evaluated because no metals exceeded guidelines established to protect human health. Metals were evaluated for wildlife because of the lack of established guidelines.

Exposure Pathways

Exposure pathways are the routes by which people may be exposed

Exposure pathways are the potential routes by which people may be exposed to emissions from the Snap Lake Diamond Project. This forms the basis for the linkage analysis. A pictorial representation of the human exposure pathways is presented in Figure 11.3-3. Exposure pathways are explained in detail in Appendix XI.1.

Figure 11.3-3 Human Exposure Pathways

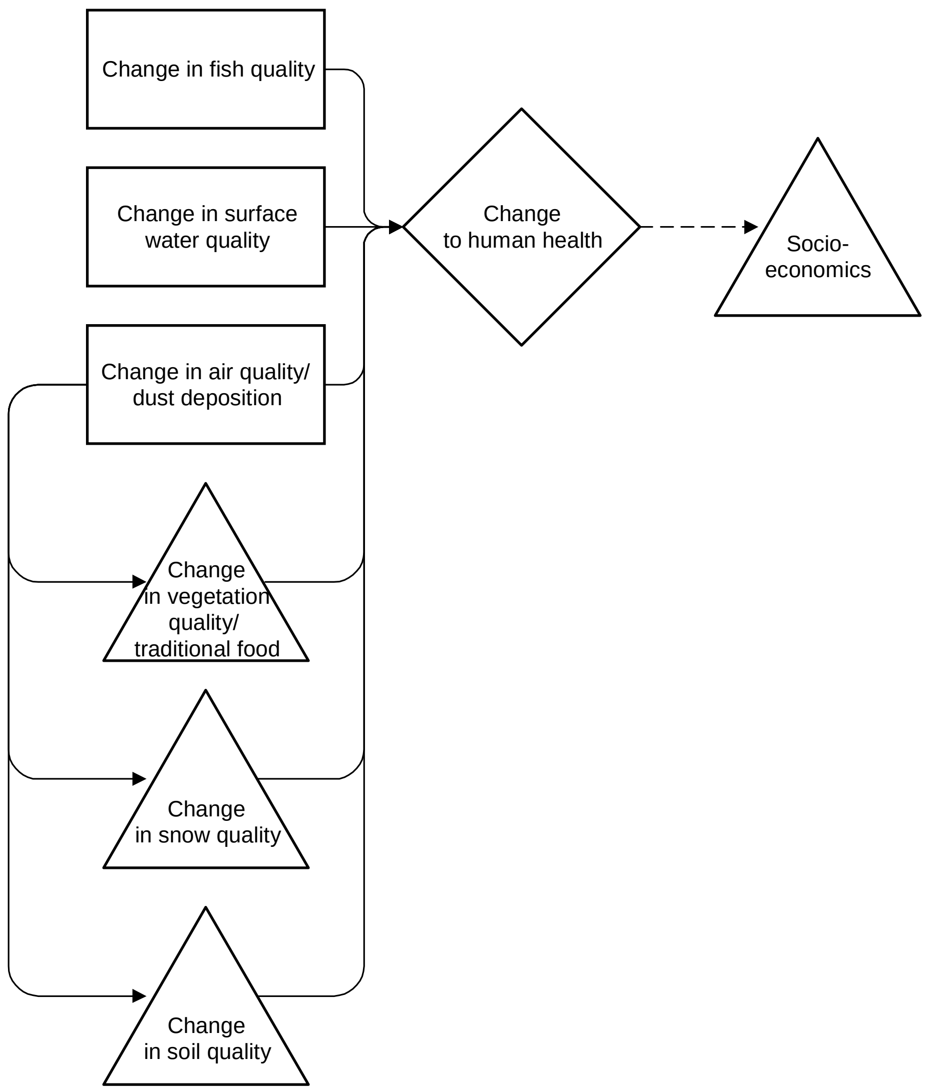
11.3.3.1.2 Linkage Analysis

The potential linkages between emissions and human health were evaluated

The potential linkages between the Snap Lake Diamond Project and human health were evaluated to answer Key Question EH-2 (Figure 11.3-4). The following four linkages were analyzed:

- linkage between changes in air quality and human health;
- linkage between changes in water and snow quality and human health;
- linkage between changes in fish tissue quality and human health; and,
- linkage between changes in plant/animal tissue quality and human health.

Figure 11.3-4 Human Health Linkage Diagram



Hunters may be exposed by direct inhalation; therefore, this linkage is valid

Hunters/trappers within the LSA and RSA may be exposed to airborne chemicals that will be emitted from the Snap Lake Diamond Project by direct inhalation. The compounds that will be emitted from the Snap Lake Diamond Project during the operational phase are metals, PAHs, particulate matter, SO_2, and NO_2. This linkage is valid and inhalation of metals, PAHs, particulate matter, SO_2, and NO_2 was evaluated in the impact assessment for the operation phase. Air emissions will cease following closure; therefore, there is no potential for effects on human health due to the Snap Lake Diamond Project airborne emissions after closure.

Drinking water from Snap Lake was evaluated for hunters in the local study area

The Snap Lake Diamond Project may release chemicals to surface water within the LSA and RSA (Section 9.4). Within the LSA, surface water (*i.e.*, Snap Lake) will receive discharge from the water treatment plant. People may use surface water bodies for drinking water while in the LSA and RSA. During the post-closure case, water quality in the north lake may be affected. Drinking water could be obtained from the north lake. Therefore, this linkage is valid and ingestion of naphthalene from water was evaluated in the impact assessment for the application case and post-closure case.

Snow ingestion was evaluated for hunters

Another source of drinking water for hunters/trappers is snow. Traditional activities may occur during the year when snow is the only drinking water source. Therefore, concentrations of metals and PAHs in snow resulting from fugitive dust emissions were predicted for the application case. This linkage is valid and ingestion of naphthalene from snow was evaluated in the impact assessment for the operation phase. Air emissions will cease after closure; therefore, this pathway is invalid for the post-closure case.

Fish tissue quality may be altered; therefore, this linkage is valid

Water quality may be altered by Snap Lake Diamond Project. Water quality in the north lake may be altered during post-closure. Fish inhabiting these waters may take up chemicals. Therefore, this linkage is valid and was addressed in the impact assessment.

Hunters do not bring large quantities of vegetation home; therefore, this linkage was not assessed

Fugitive dust from the site containing metals and PAHs may deposit directly onto the surface of plants or may deposit onto soils and be subsequently taken up through plant roots. While people may eat berries and other vegetation during the fall hunting season, they are unlikely to bring large quantities back to the communities (Lutsel K'e Dene First Nation 2001). The majority of the vegetables and fruits eaten by people in the communities are from sources other than the study area. Although people may be indirectly exposed to chemicals in plants that have been consumed by game animals, the direct linkage between plants and people is weak and was not addressed in the impact assessment for the application case.

Consumption of game meat was evaluated

The Snap Lake Diamond Project will potentially emit fugitive dust from its activities. In addition, people may eat meat from animals that have consumed plants growing within the RSA and/or LSA. Therefore, indirect uptake of chemicals from the project through consumption of game meat is possible. Thus, the linkage between changes in animal tissue quality and human health is valid and was evaluated in the impact assessment for the application case.

11.3.3.2 Mitigation

Mitigation for air and water quality is protective of human health

Mitigation for emissions that may impact human health are defined in Section 7.4 and Section 9.4 for air quality and water quality, respectively. Mitigation for air and water quality is protective of human health because concentrations of chemicals of concern are reduced by mitigation in all exposure pathways.

11.3.3.3 Impact Analysis

11.3.3.3.1 Exposure Assessment

This assessment determines the amount of exposure

The exposure assessment is a process for determining the amount of each chemical to which each receptor is likely to be exposed within the LSA and RSA when the project is in operation.

11.3.3.3.2 Temporal and Spatial Boundaries

Temporal and spatial boundaries define the area of exposure

Temporal and spatial boundaries are required to define the area that may be temporarily inhabited by hunters and where hunters are likely to be exposed to chemicals from the project.

Community members may hunt and eat traditional foods from within local and regional study areas

There are no communities within 200 km of the Snap Lake Diamond Project. Communities at this distance from the project site would not be impacted by dust emissions or water emissions from the project (Sections 7.3 and 9.4). However, individuals from the following communities are most likely to be hunting wildlife and therefore eating traditional foods from within LSA and RSA:

- Yellowknife;
- Dettah;
- N'Dilo;
- Lutsel K'e;
- Rae/Edzo;

- Rae Lakes (Gameti);
- Wekweti; and,
- Wha Ti.

A hunter was estimated to be in the local and regional study areas 30 days per year

For each of the two cases (*i.e.*, baseline, application), direct exposure to chemicals for a hypothetical hunter/fisher was evaluated for 30 days per year for 25 years (duration of the application case). The typical length of a hunting trip is two to three weeks (S. Ellis, Lutsel K'e Dene First Nation, telephone conversation). Indirect exposure through the consumption of harvested foods (*i.e.*, game, fish) was evaluated based on the amount of food that may be harvested during the 30-day period for each year throughout the approximately 25-year duration of the Snap Lake Diamond Project.

The regional study area was not specifically evaluated for human health because the local study area results can be used to represent "worst-case"

The RSA was not specifically evaluated for human health. Rather, it was conservatively assumed that a hunter/trapper would spend all of his hunting time within the LSA. This is a conservative assumption because it is unlikely that an individual would be hunting/trapping within 500 m of the mine footprint (*i.e.*, LSA area). It is also unlikely that an individual would be hunting/trapping in the LSA for 30 days per year since the potential hunting areas in the Northwest Territories are vast and the aesthetic quality of hunting next to an active mine site would likely be low. Hunters are more likely to take advantage of hunting opportunities closer to the primary communities. Since chemical concentrations are higher in the LSA than the RSA, assuming a hunter spends 30 days within the LSA is considered to be the worst-case possible. Therefore, if risks are acceptable (*i.e.*, if ERs are less than one) for this exposure, risks would also be acceptable for other exposures (*e.g.*, less time in the LSA, or time in the RSA).

11.3.3.3.3 Receptor Exposure Parameters

Exposure parameter were from published literature

For each life stage, information on body weights, ingestion rates, and inhalation rates were gathered from published scientific literature (CCME 1996; Richardson 1997). Receptor exposure parameters are presented in Appendix XI.1.

11.3.3.3.4 Exposure Estimates

Concentrations of naphthalene were predicted for the application case

Concentrations of naphthalene were predicted for each exposure medium for the application case. Air quality and water quality predictions are presented in Sections 7.3 and 9.4. Predicted concentrations of naphthalene in soil, vegetation, food, and snow are presented in Appendix XI.1. The average predicted concentrations were used because, in most cases, deposition of naphthalene would be expected to be patchy and emission rates and weather conditions correlated with deposition rates would be highly variable. Therefore, the distribution of naphthalene concentrations across the LSA or RSA would not be expected to be uniformly high.

Exposures for each pathway were added

Exposures to the chemicals of concern for each exposure pathway were added to determine the overall exposure. Detailed exposure estimates are presented in Appendix XI.1.

11.3.3.3.5 Toxicity Assessment

Toxicity assessment involves classification of the potential toxic effects

Toxicity assessment involves classification of the potential toxic effects of chemicals and the estimation of the amounts of chemicals that can be received by human receptors without adverse health effects. Toxicity assessment is conducted for all chemicals of potential concern.

Toxicity information is based on experiments with laboratory animals

The majority of toxicity information is based on results from experiments with laboratory animals. Some additional information on human health effects is also available for some substances where cases of workplace exposures and associated health effects have been documented.

Toxicity reference values are used to evaluate chemicals

In the toxicity assessment, toxicity information for each chemical was used to provide quantitative estimates of health effects associated with exposure to site chemicals. Naphthalene is not carcinogenic. Toxicity reference values used to evaluate non-carcinogenic chemicals are called reference doses (RfDs) or reference concentrations (RfCs; for inhalation) and describe a daily intake rate considered to be without adverse effect to sensitive members of the population over a lifetime. Toxicity reference values used in this assessment are based on dose-response toxicity evaluations available through agencies and toxicological databases such as Health Canada (2001), and IRIS (integrated risk information system) (2001), U.S. Environment Protection Agency (U.S. EPA) (2001) on-line database. Further details on the toxicology of naphthalene are provided in Appendix XI.1.

11.3.3.3.6 Risk Characterization

An exposure ratio was calculated for each chemical of concern

ERs were calculated as the ratio of the predicted exposure to the toxicity reference value, according to the following equation:

$$ER = \frac{\text{estimated exposure}}{\text{reference dose (or concentration)}}$$

If the exposure ratio is less than one, there is no potential health risk

An ER was calculated for each age group, based on the estimated intake rate (dose) and the toxicity reference value. For naphthalene, an ER value of less than one represents exposures that do not pose a health risk (Health Canada [unpublished] 1995). When the ER is greater than one, the exposures pose a potential concern and require further scrutiny. It is important to note that ER values greater than one do not necessarily indicate that adverse health effects will occur due to the layers of safety employed in their estimation. Because of the layers of safety, if the exposure is less than the toxicity reference value, we can be confident that there will be no impacts. Refer to Appendix XI.1 for specific methods used in the human health impact assessment.

All of the exposure ratios are less than one

In the present assessment, all of the predicted ERs are less than one and ERs are similar between baseline and application cases (Tables 11.3-5 and 11.3-6). Therefore, direct exposure (*i.e.*, inhalation of dust, drinking water, eating soil and vegetation) and indirect exposure (*i.e.*, ingesting meat) to naphthalene emitted from the Snap Lake Diamond Project will not result in adverse human health impacts. Due to the conservative nature of the risk assessment, there is a high degree of confidence that people would not be exposed to naphthalene in their environment that would impact their health. The post-closure case was not evaluated because concentrations of metals that exceeded baseline concentrations were less than drinking water quality guidelines (Appendix XI.1).

Table 11.3-5 Exposure Ratios Related to People Hunting within the Local Study Area

Receptor/Chemical	Baseline	Application
Toddler		
Naphthalene	0.002	0.3
Child		
Naphthalene	0.0008	0.06
Adult		
Naphthalene	0.00003	0.03

Table 11.3-6 Exposure Ratios for People in Communities

Receptor/Chemical	Baseline	Application
Toddler		
Naphthalene	-	0.0003
Child		
Naphthalene	-	0.0003
Adult		
Naphthalene	-	0.0002

11.3.3.4 Residual Impact Classification

Risk estimates stand alone as an expression of impact on human health

As explained for wildlife health, the risk estimates for human health cannot directly be converted to a residual impact classification because of fundamental differences in assessment methodology. Therefore, the risk estimates stand alone as the expression of impact on human health.

People will not be exposed to chemicals emitted from the Snap Lake Diamond Project that will result in adverse health effects

All predicted ERs are less than one and the ERs are similar between the baseline and application cases for human health. The post-closure case was not evaluated because concentrations of metals that exceeded baseline concentrations were less than drinking water quality guidelines (Appendix XI.1). There is a high degree of confidence that people will not be exposed to chemicals emitted from the Snap Lake Diamond Project that will result in adverse health effects.

Assumptions were biased towards safety

There is always uncertainty associated with risk assessment predictions, depending on the quality, quantity, and variability associated with available information. When information is uncertain, it is standard practice in a risk assessment to make assumptions that are biased towards safety, so that even if there is uncertainty, human health will still be protected.

The assessment was conservative

This assessment was based on many layers of safety, including the following:

- conservative thresholds for effect that incorporate safety factors when extrapolating from laboratory animals to humans; and,
- reasonable maximum exposure parameters (*i.e.*, people hunting for 30 days per year in the LSA and people in communities eating meat solely from the LSA for 365 days per year).

Collectively, these assumptions weigh heavily towards ERs that over-estimate the true to human health due to the Snap Lake Diamond Project.

Level of confidence is rated as high for the human health impact assessment

The uncertainties inherent in modelling exposures are compensated for by the conservative input parameters used. There is considerable certainty that the risks have not been underestimated because of the offsetting effect of the layers of safety employed. Therefore, the level of confidence is high that exposure will not be greater than predicted in the human health impact assessment.

11.3.3.5 Mitigation and Monitoring

Mitigation measures are not recommended

Since impacts to human health are not predicted, additional mitigation measures beyond those already planned and committed to for air and water quality are not necessary. Air quality and water quality monitoring programs are discussed in Sections 7.4 and 9.4, respectively. No additional monitoring is necessary because air and water quality monitoring data can be used to confirm exposure estimates used in this assessment.

11.4 CONCLUSIONS

The environmental assessment evaluated whether health impacts would occur due to exposure to emissions

The Snap Lake Diamond Project will release metals and PAHs while it is in operation. The EA evaluated whether health effects would occur to people and wildlife that might be in the LSA and RSA, during the application case and post-closure case. In addition, people in communities outside of the RSA may eat meat and fish that have been exposed to emissions in the RSA. Therefore, the EA evaluated whether health impacts would occur due to ingestion of caribou meat and fish. Air emissions will cease following closure; therefore, airborne chemicals will not impact human and wildlife health. However, due to groundwater seepage, effects on water quality in the north lake may occur post-closure.

Risk assessment was used to determine:

- the metals and PAHs that will be released from the Snap Lake Diamond Project;
- the metals and PAHs that will exceed baseline concentrations and/or established guidelines for the protections of human or wildlife health; and,
- the people and wildlife that might come in contact with the substances.

Exposure levels were compared to levels that are safe for people and wildlife

The assessment estimated the levels of metals and PAHs that people and wildlife might be exposed to while in the LSA and RSA. These levels were then compared to benchmark levels that are protective of human and wildlife health. These benchmark levels were derived from scientific studies and will protect people and wildlife. If the levels in the environment are less than benchmark levels, health problems should not occur. On the other hand, if levels in the environment are higher than benchmark levels, the risk assessment would predict that health problems might occur, and further assessment would be needed.

No impacts are predicted for human and wildlife health

No impacts are predicted for human and wildlife health. Exposures to chemicals emitted from the Snap Lake Diamond Project are less than benchmark doses derived for the protection of human and wildlife health, with the exception of aluminum for wildlife health. However, aluminum exposure is similar in both baseline and application cases. Aluminum is present naturally in soils. Most of this naturally occurring aluminum is not available for uptake in wildlife. However, without site-specific information on soil characteristics (*i.e.*, cation-exchange capacity, organic content, pH) it is not possible to estimate how much of the naturally occurring aluminum is available. Therefore, the prediction of an exposure greater than benchmark doses for aluminum is likely over-estimated since 100% availability was assumed. Since ERs predicted for the application case are similar to the baseline case, no incremental risks to wildlife health are predicted.

There is considerable certainty that the risks have not been underestimated

There is considerable certainty that the risks have not been underestimated because of the offsetting effect of the layers of safety employed. Therefore, the level of confidence is rated as high for the wildlife and human health impact assessments. Consequently, no additional mitigation measures beyond those already planned and committed to are recommended. Air quality and water quality monitoring discussed in Sections 7.3 and 9.4, respectively, will also ensure the protection of human and wildlife health.

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11.6 UNITS, ACRONYMS, AND GLOSSARY

UNITS

$\mu g/m^3$	microgram per cubic metre
ha	hectare
km	kilometre
mg/kg	milligram per kilogram
mg/L	milligram per litre

ACRONYMS

AEP	advanced exploration program
CCME	Canadian Council of Ministers of the Environment
CEA	cumulative effects assessment
COC	chemicals of concern
De Beers	De Beers Canada Mining Inc.
EA	environmental assessment
ELC	ecological land classification
ER	exposure ratio
IRIS	integrated risk information system
LOAEL	lowest observed adverse effect level
LSA	local study area
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NO_2	nitrogen oxide
NOAEL	no observed adverse effect level
PAH	polycyclic aromatic hydrocarbon
RAIS	risk assessment information system
RfC	reference concentrations

RfD	reference doses
RSA	regional study area
RWED	Resources, Wildlife and Economic Development
SO_2	sulphur dioxide
TSP	total suspended particulate
U.S. EPA	United States Environmental Protection Agency
VEC	valued ecosystem component

GLOSSARY

application case	represents the impact predicted to occur due to the Snap Lake Diamond Project; this case is based on impact when the project is fully developed and the activities at the mine site will be at a maximum
baseline case	the current environmental setting, against which changes in the environment from the Snap Lake Diamond Project could be assessed; as there are no approved developments within the regional study area (RSA), the baseline case focuses on summarizing the available monitoring data gathered at the Snap Lake Diamond Project
benchmark dose	the chemical dose at which toxic effects may occur in wildlife receptors; derived from the lowest observed adverse effect levels for laboratory test species
contaminants	a general term referring to any chemical compound added to a receiving environment in excess of natural concentrations; the term includes chemicals or effects not generally regarded as "toxic," such as nutrients, colour and salts
detection limit	the lowest concentration that a laboratory can determine; therefore, a concentration measured in water, soil, fish, plants, snow or sediment can never be reported as zero but is a number that is less than the detection limit (*i.e.*, <10); when a number such as <10 is presented in the text, it means that the concentration is too low to be measured; therefore, the concentration in that sample is something less than 10 units
exposure	the contact reaction between a chemical and a biological system, or organism
exposure assessment	estimates the amount of a chemical a receptor may take into its body through all applicable exposure pathways

exposure ratio (ER)	the ratio of the exposure estimate to the toxicity benchmark; a measure of the magnitude of the potential adverse effect to individual animals associated with exposure to chemicals emitted from the Snap Lake Diamond Project; an ER less than 1 indicates that there are no risks/impacts to wildlife health from the predicted exposures to the chemicals of concern; an ER greater than 1 indicates that there is a potential for effects on some individuals
footprint	the land lease area for the project that includes the active mine area
fugitive dust	dust that is difficult to grasp or retain
inhalable particles (PM_{10})	particles that are 10 microns or smaller in diameter; fine particulate matter that can reach the lungs
kimberlite	an agglomerate biotite-peridotite that occurs in pipes especially in southern Africa and that often contains diamonds
lemming	a small, short-tailed furry-footed rodent
lichen	complex plants made up of an alga and a fungus growing in symbiotic association on a solid surface; lichens take up chemicals efficiently and readily via dust deposition, thus are commonly used as indicator species
linkage diagrams	diagram that is used to depict cause and effect pathways
polycyclic aromatic hydrocarbon (PAH)	a chemical byproduct of petroleum-related industry; aromatics are considered to be highly toxic components of petroleum products; PAHs, many of which are potential carcinogens, are composed of at least two fused benzene rings; toxicity increases along with molecular size and degree of alkylation of the aromatic nucleus
respirable particles ($PM_{2.5}$)	particles that are 2.5 microns or smaller in diameter; fine particulate matter that is able to reach the lungs, and go deeper into the respiratory tract and may have greater deleterious health impacts than the coarser inhalable particles (PM_{10})
risk	the likelihood or probability that the toxic effects associated with a chemical or physical agent will be produced in populations of individuals under their actual conditions of exposure; risk is usually expressed as the probability of occurrence of an adverse effect, (*i.e.*, the expected ratio between the number of individuals that would experience an adverse effect at a given time and the total number of individuals exposed to the factor); risk is expressed as a fraction without units and takes values from 0 (absolute certainty that there is no risk, which can never be shown) to 1.0, where there is absolute certainty that a risk will occur

risk characterization	compares the amount of exposure predicted for each receptor (exposure assessment) to the chemical dose at which toxic effects may begin to occur in wildlife receptors (toxicity assessment)
toxicity	the inherent potential or capacity of a material to cause adverse effects in a living organism
toxicity assessment	defines the toxicity of the chemicals of concern and the chemical dose at which toxic effects may begin to occur in wildlife receptors
traditional knowledge	information obtained more often through observations primarily by Aboriginal people during extensive time spent in one geographic location than through information obtained formally by the scientific method
uncertainty	imperfect knowledge concerning the present or future state of the system under consideration; a component of risk resulting from imperfect knowledge of the degree of hazard or of its spatial and temporal distribution
valued ecosystem component (VEC)	a component of the environment that is representative of traditional, public and scientific values, *e.g.*, rare plant potential and traditional plant potential
worst-case	a semi-quantitative term referring to the maximum possible exposure, dose or risk, that can conceivably occur, whether or not this exposure, dose, or risk actually occurs is observed in a specific population; it should refer to a hypothetical situation in which everything that can plausibly happen to maximize exposure, dose, or risk does happen; the worst-case may occur in a given population, but since it is usually a very unlikely set of circumstances in most cases, a worst-case estimate will be somewhat higher than what occurs in a specific population