# SECTION 12

# BARREN-GROUND CARIBOU

# Section 12 Table of Contents

## Maps

## Figures



## Tables

## Appendices

# Section 12 Abbreviations

| Abbreviation | Definition |
|---|---|
| % CI | percent confidence interval |
| BSA | baseline study area |
| CO | carbon monoxide |
| Coef. | coefficient |
| DAR | Developer’s Assessment Report |
| DC | disturbance coefficients |
| Diavik Mine | Diavik Diamond Mine |
| DKFN | Deninu Kué First Nation |
| Dominion Diamond | Dominion Diamond Ekati Corporation |
| e.g. | for example |
| Ekati Mine | Ekati Diamond Mine |
| ENR | Environment and Natural Resources |
| EOSD | Earth Observation for Sustainable Development |
| ESA | effects study area |
| et. al | and more than one additional author |
| FMR | fasting metabolic rate |
| GIS | Geographic Information System |
| GNWT | Government of the Northwest Territories |
| i.e. | that is |
| ICRP | Interim Closure and Reclamation Plan |
| IHI | insect harassment index |
| Jericho Mine | Jericho Diamond Project |
| KIA | Kitikmeot Inuit Association |
| KLOI | Key Line Of Inquiry |
| LKDFN | Łutselk’e Dene First Nation |
| LLCF | Long Lake Containment Facility |
| MDNN | mean distance to nearest neighbour |
| MVRB | Mackenzie Valley Review Board |
| n.d. | no date |
| non-PAG | non-potentially acid generating |
| $NH_3$ | ammonia |
| $NO_x$ | oxides of nitrogen |
| NSMA | North Slave Métis Alliance |
| NWT | Northwest Territories |
| PAG | potentially acid generating |
| $PM_{2.5}$ | particulate matter with a mean aerodynamic diameter of 2.5 microns (µm) or smaller |
| RFD | Reasonably Foreseeable Development Case |
| RSF | resource selection function |
| SD | standard deviation |
| Snap Lake Mine | Snap Lake Diamond Mine |

| Abbreviation | Definition |
|---|---|
| $SO_2$ | sulphur dioxide |
| $SO_x$ | oxides of sulphur |
| TCWR | Tibbitt to Contwoyto Winter Road |
| TK | Traditional Knowledge |
| TSP | total suspended particulate |
| the Project | Jay Project |
| VC | valued component |
| WEMP | Wildlife Effects Monitoring Plan |
| WPKMP | Wastewater and Processed Kimberlite Management Plan |
| WROMP | Waste Rock and Ore Storage Management Plan |
| WRSA | waste rock storage area |
| YKDFN | Yellowknives Dene First Nation |
| ZOI | zone of influence |

# Section 12 Units of Measure

| Unit | Definition |
|---|---|
| ± | plus or minus |
| % | percent |
| < | less than |
| > | greater than |
| °C | degrees Celsius |
| $\mu g/m^3$ | micrograms per cubic metre |
| $g/m^2/d$ | grams per square metre per day |
| ha | hectare |
| keq/ha/yr | kiloequivalent per hectare per year |
| kg | kilogram |
| kg/ha/y | kilograms per hectare per year |
| km | kilometre |
| km/h | kilometres per hour |
| $km/km^2$ | kilometres per square kilometre |
| $km^2$ | square kilometre |
| kV | kilovolts |
| m | metre |
| m/s | metres per second |
| MJ | megajoules |
| MJ/day | megajoules per day |
| MJ/kg/h | megajoules per kilogram per hour |
| MJ/kg/km | megajoules per kilogram per kilometre |
| MW | megawatt |

# 12 BARREN-GROUND CARIBOU

## 12.1 Introduction

### 12.1.1 Background

The existing Dominion Diamond Ekati Corporation (Dominion Diamond) Ekati Diamond Mine (Ekati Mine) and surrounding claim block are located approximately 300 kilometres (km) northeast of Yellowknife in the Northwest Territories (NWT) (Map 12.1-1). Dominion Diamond proposes to develop the Jay Project (Project), which includes the Jay Pit, along with associated mining and transportation infrastructure (Map 12.1-2) to add 10 or more years of operations life to the Ekati Mine. The majority of the facilities required to support the Project and process the Jay kimberlite pipe already exist at the Ekati Mine, including:

- Misery Pit mining infrastructure (e.g., fuel facility, explosives magazines);
- primary roads and transportation infrastructure (e.g., Ekati airstrip, Misery Road);
- Ekati main camp and supporting infrastructure;
- Ekati processing plant; and,
- fine processed kimberlite management facilities.

The Jay kimberlite pipe is located beneath Lac du Sauvage in the southeastern portion of the Ekati claim block, approximately 7 km northeast of the Misery Pit (Map 12.1-2). A horseshoe-shaped dike will be constructed to isolate the portion of Lac du Sauvage overlying the Jay kimberlite pipe. The isolated portion of Lac du Sauvage will be dewatered to allow open-pit mining of the kimberlite pipe. The Project will also require an access road, pipelines, and power lines to the new open pit.

### 12.1.2 Purpose and Scope

This section of the Developer's Assessment Report (DAR) for the Project addresses the Key Line of Inquiry (KLOI): Impacts to Caribou from Project Components identified in the Terms of Reference issued on February 21, 2014 by the Mackenzie Valley Review Board (MVRB). The entire Terms of Reference document is included in Appendix 1A, and the Table of Concordance for the DAR is provided in Appendix 1D of Section 1.

The KLOIs were identified by the MVRB based on concerns expressed by various interested parties and the general public during the MVRB scoping exercise. Each KLOI requires the most attention during the environmental impact review, and the most rigorous analysis and detail in the DAR.

The purpose of this section is to meet the Terms of Reference issued by the MVRB and, specifically, to assess the effects of the Project on barren-ground caribou populations. This section includes a detailed and comprehensive assessment of all potential impacts from the Project and other developments on barren-ground caribou.


## LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- NORTH SLAVE REGION

150 0 150

SCALE 1:6,000,000 KILOMETRES

## REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

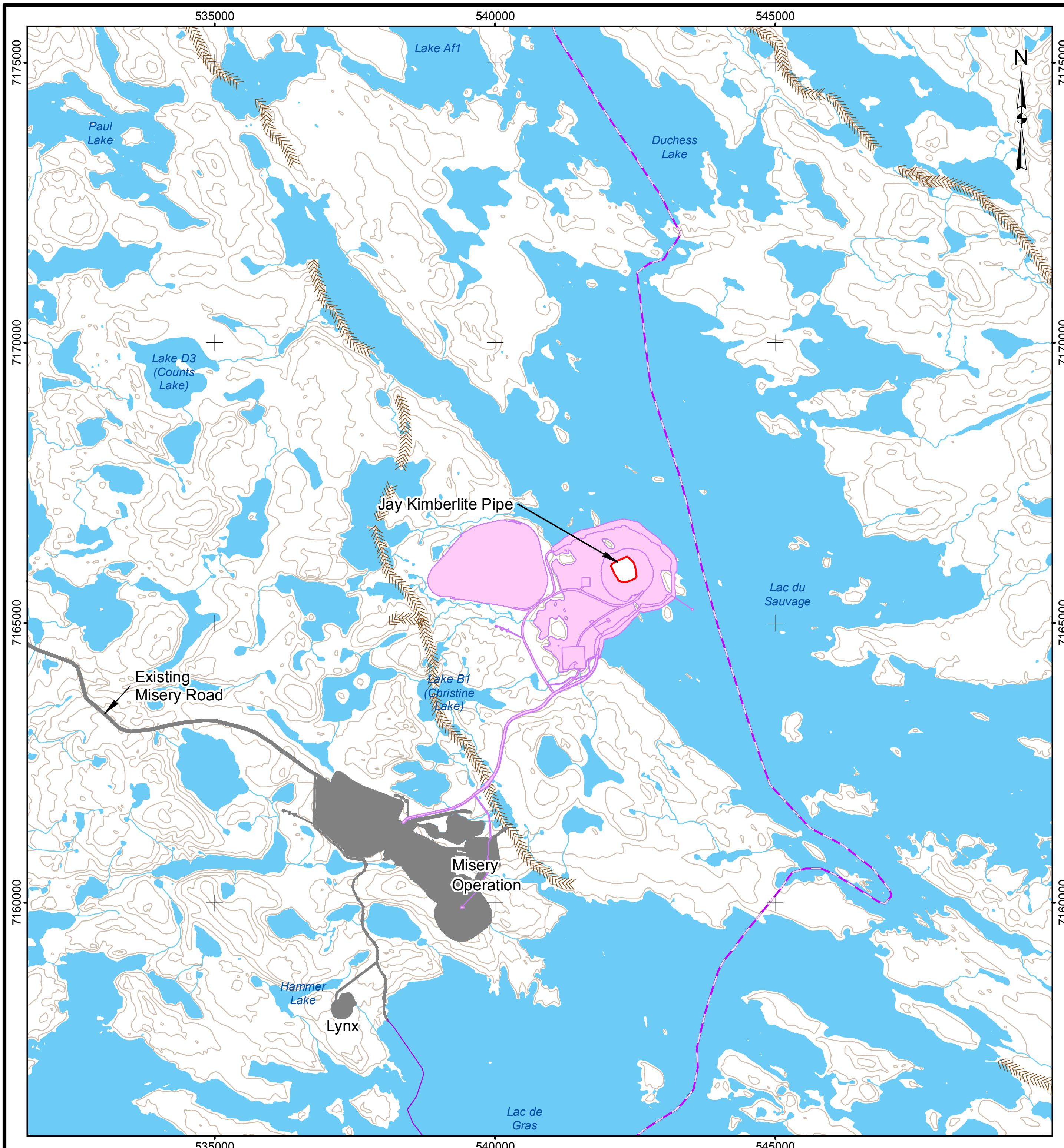
TITLE

# LOCATION OF THE JAY PROJECT

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_058_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 02/10/14 | MAP 12.1-1 | |
| CHECK | JR | 02/10/14 | | |
| REVIEW | LD | 02/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_058_GIS.mxd




G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_094_GIS.mxd

## LEGEND

- EKATI MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- KIMBERLITE PIPE
- WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (10 m INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY

2 0 2

SCALE 1:100,000 KILOMETRES

## REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

# LOCATION OF THE JAY KIMBERLITE PIPE

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_094_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 01/05/14 | SCALE AS SHOWN | REV. 0 |
| GIS | NS | 03/10/14 | MAP 12.1-2 | |
| CHECK | JR | 03/10/14 | | |
| REVIEW | LD | 03/10/14 | | |

### 12.1.3 Valued Components, Assessment Endpoints, and Measurement Indicators

Barren-ground caribou are an important cultural and economic resource for people in the NWT, and were identified as a valued component (VC) in the Terms of Reference. Assessment endpoints are qualitative expressions used to assess the significance of effects on VCs and represent the key properties of VCs that should be protected for future human generations (i.e., incorporate sustainability). Identification of VCs and assessment endpoints was determined partially from the outcome of the community (including local and traditional knowledge), public, and regulatory engagement process (Section 4).

A self-sustaining and ecologically effective population is the assessment endpoint for barren-ground caribou (Table 12.1-1). Self-sustaining populations are healthy, robust populations capable of withstanding environmental change and accommodating random demographic processes (Reed et al. 2003). For VCs that have strong effects on ecosystem structure and function (i.e., highly interactive species), such as barren-ground caribou, the concept of ecologically effective populations is also used (Soulé et al. 2003). Local and traditional knowledge recognizes the importance of caribou to the health of the land, predators, and people (Section 5). An ecologically effective population of a highly interactive species is one that is large enough to maintain ecosystem function.

Measurement indicators represent properties of the environment and the VC that, when changed, could result in, or contribute to, an effect on the assessment endpoint. For example, the area of habitats, connectivity between habitats, and quality of habitat (which influences animal occupancy, movement, and behaviour) are measurement indicators for the assessment endpoint of the barren-ground caribou VC (Table 12.1-1). Measured and predicted changes in survival and reproduction are also used to indicate the influence of human-related and natural factors on the assessment endpoint, and include results from other disciplines such as the wildlife health risk assessment.

The assessment of caribou focuses on measurement indicators and assessment endpoints derived from ecology and conservation science. Community and regulatory engagement, and local and traditional knowledge were a key consideration for selecting VCs, but assessment endpoints for caribou do not explicitly consider societal values, such as continued opportunities for traditional and non-traditional use of caribou. Societal values concerning changes in caribou populations are important and must also be considered to understand the full suite of potential effects of the Project (i.e., both human and ecological dimensions). Consequently, measurement indicators from the caribou section were carried forward so that effects on societal values could be appropriately captured in the sections dealing specifically with those values (Culture: Section 15).

**Table 12.1-1 Summary of the Valued Component, Assessment Endpoint, and Measurement Indicators**

| Valued Component | Assessment Endpoint | Measurement Indicators |
|---|---|---|
| Barren-ground caribou | • Self-sustaining and ecologically effective caribou populations | • Habitat quantity<br>• Habitat arrangement and connectivity (fragmentation)<br>• Habitat quality (occupancy, movement, and behaviour)<br>• Survival and reproduction<br>• Abundance and distribution of caribou |

## 12.1.4 Spatial Boundaries

### *12.1.4.1 General Setting*

The Project is located in the Level III Tundra Shield Low Arctic (south) Ecoregion in the Level II Tundra Shield Ecoregion (Ecosystem Classification Working Group 2012). Soils in the Level III Tundra Shield Low Arctic (south) Ecoregion are dominantly Crysols, with Brunisols and Regosols in rockland areas. Vegetation in the Tundra Shield Low Arctic (south) Ecoregion is primarily characterized by continuous to discontinuous low-shrub and erect dwarf-shrub tundra.

### *12.1.4.2 Baseline Study Area*

The baseline study area (BSA) was designed to characterize existing environmental conditions at various spatial scales ranging from the Project site to broader, regional levels (Section 6.3.1). Data collected at the Project site and local scales were used to provide precise measures of baseline environmental conditions, and to predict the direct and indirect changes from the Project on caribou (e.g., changes to terrestrial habitat from the physical footprint and dust and air emissions). Data collected at larger scales were used to measure broader-scale baseline environmental conditions, and provide regional context for the combined direct and indirect effects from the Project on barren-ground caribou. The BSA is approximately 5,933 square kilometres ($km^2$) (Wildlife Baseline Report, Annex VII).

The BSA was selected to be an appropriate spatial boundary for quantifying baseline conditions on caribou. Barren-ground caribou may be present in the BSA during the northern migration (May 1 to 31), post-calving aggregation (June 16 to July 1), summer dispersal (July 2 to August 31), and fall migration (September 1 to October 31) periods (Rescan 2012), and their range use and response to industrial activity are important factors in the BSA delineation.

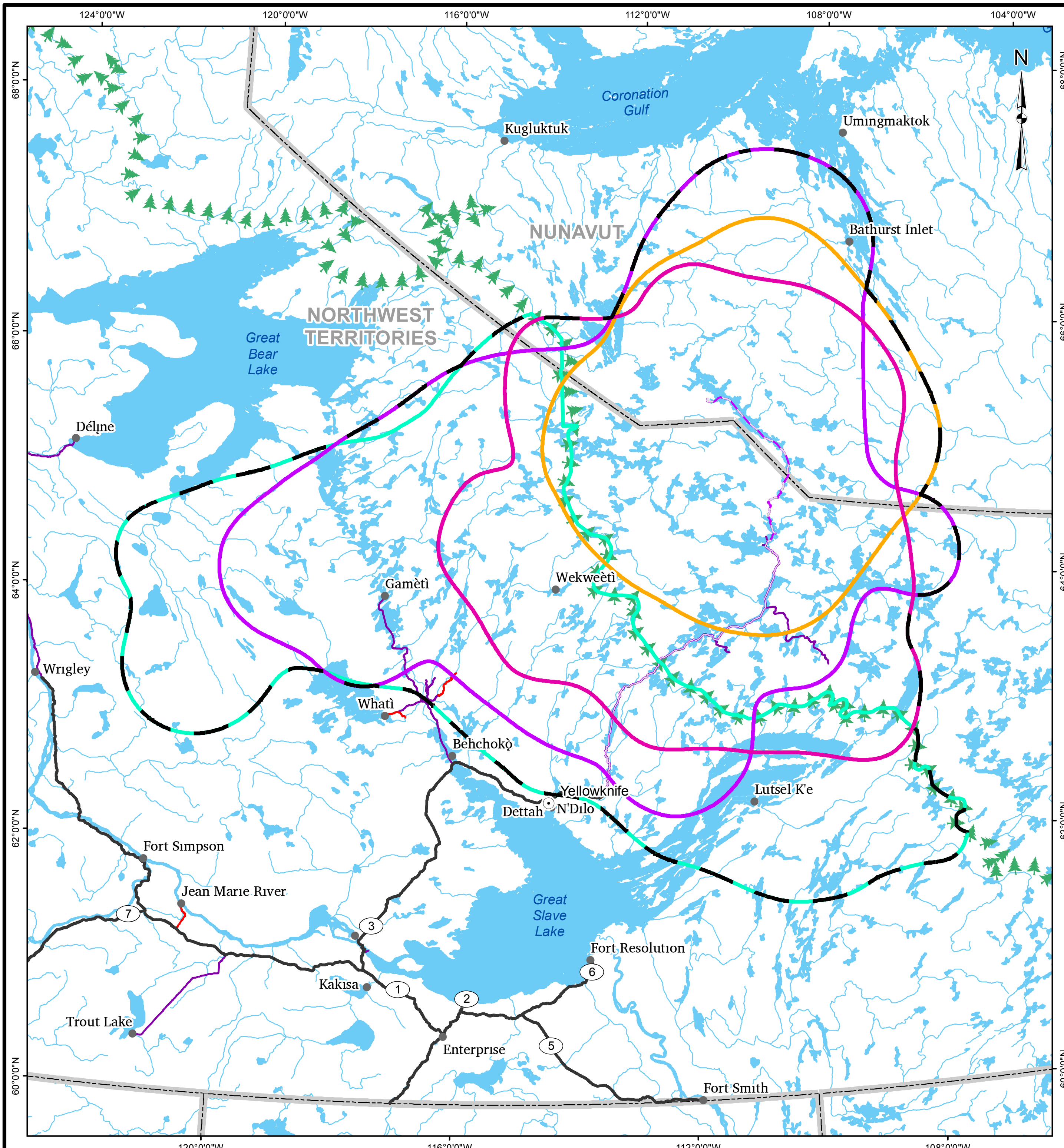
Current estimates for the zone of influence (ZOI) from the Ekati Mine and the Diavik Diamond Mine (Diavik Mine) on caribou, which range from 6.5 to 40 km (Boulanger et al. 2004, 2012; Johnson et al. 2005; Golder 2011a), were also used to define the BSA. These studies reported that caribou were more likely to occur further from diamond mines and other developments than close to them. The BSA was selected to capture the zone of influence from the Project, the Ekati and Diavik mines, and reference areas (i.e., areas outside the ZOI).

#### 12.1.4.3 Barren-Ground Caribou Effects Study Area

The caribou effects study area (ESA; Map 12.1-3) includes the four seasonal ranges (spring, post-calving, autumn, and winter) of the Bathurst caribou herd. These ranges were delineated from radio-collar and Global Positioning System collar data that were collected from April 1996 to October 2013 from individuals of the Bathurst caribou herd.

The largest seasonal range is the spring range (April 15 to June 14), which is 200,063 $km^2$. The post-calving range (June 15 to August 31) is the smallest seasonal range at 89,009 $km^2$. The autumn range (September 1 to October 31) is 139,054 $km^2$, and the winter range (November 1 to April 30) is 159,509 $km^2$ (see Section 12.4.2.1.1 for explanation of seasonal ranges). The combined annual range of the Bathurst herd was determined to be 305,780 $km^2$.

Although the Project is not within the winter range, the assessment of cumulative effects on the Bathurst herd requires that effects on all seasonal ranges be considered. The caribou ESA was determined based on the ranges for the Bathurst herd because this herd has the greatest likelihood of interacting with the Project relative to the Ahiak and Beverly herds (Section 12.2.2.1).




## LEGEND

- ⊙ TERRITORIAL CAPITAL
- ● POPULATED PLACE
- HIGHWAY
- WINTER ROAD
- ALL-SEASON ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- BARREN-GROUND CARIBOU EFFECTS STUDY AREA

**CARIBOU EFFECTS STUDY AREA**

- AUTUMN MIGRATION RANGE
- POST-CALVING RANGE
- SPRING RANGE
- WINTER RANGE

100 0 100

SCALE 1:5,000,000 KILOMETRES

## REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

# BARREN-GROUND CARIBOU EFFECTS STUDY AREA

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_059_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 02/10/14 | **MAP 12.1-3** | |
| CHECK | JR | 02/10/14 | | |
| REVIEW | LD | 02/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_059_GIS.mxd

# 12.2 Existing Environment

## 12.2.1 Methods

### *12.2.1.1 Review of Regional Effects Monitoring and Research*

#### *12.2.1.1.1 Ekati and Diavik Mines*

**Caribou Aerial Surveys**

Caribou aerial surveys were completed at the Ekati Mine from 1998 to 2009 and in 2012, and at the Diavik Mine from 1995 to 2009 and in 2012. Survey methods changed in timing and coverage over time. Details on the frequency of surveys and the changes in study areas are provided in Table 12.2-1. Coverage of the survey varied as the total size of the study areas changed.

**Table 12.2-1 Caribou Aerial Survey Frequencies and Study Areas for the Ekati and Diavik Mines, 1995 to 2012**

| Year | Survey Timing and Frequency | Study Area | Coverage | Number of Transects | Number of Segments |
|---|---|---|---|---|---|
| 1995 to 1997 | • Weekly from mid-April to mid-October in the regional study area<br>• Frequency of surveys in the regional study area varied depending on caribou abundance, distribution, and presence of large herds | Diavik – 1,200 $km^2$ | Varied | varied | varied |
| 1998 to 2001 | • Weekly from mid-April to mid-October | Ekati – 1,600 $km^2$ | Ekati<br>1998 to 1999: 50%;<br>1999 to 2001: 30% | 10 | 393 |
| 2002 to 2005 | • Weekly from mid-April to mid-October<br>• Every second transect from mid-June to mid-July | Ekati and Diavik (combined) – 2,800 $km^2$ | 30% | 13 | 675 |
| 2006 | • Weekly from mid-April to mid-October | Ekati – 5,425 $km^2$<br>Diavik – 1,870 $km^2$ | Ekati 15%<br>Diavik 31% | 18 | 968 |
| 2007 and 2008 | • No northern migration surveys<br>• Weekly surveys from mid-July to mid-October | Ekati – 5,425 $km^2$<br>Diavik – 2,867 $km^2$ | Ekati 15%<br>Diavik 31% | 19 | 1,138 |
| 2009 and 2012 | • No northern migration surveys<br>• Weekly surveys from mid-July to mid-October | Ekati and Diavik (combined) – 5,933 $km^2$ | 15% | 12 | 696 |

$km^2$ = square kilometre; % = percent.

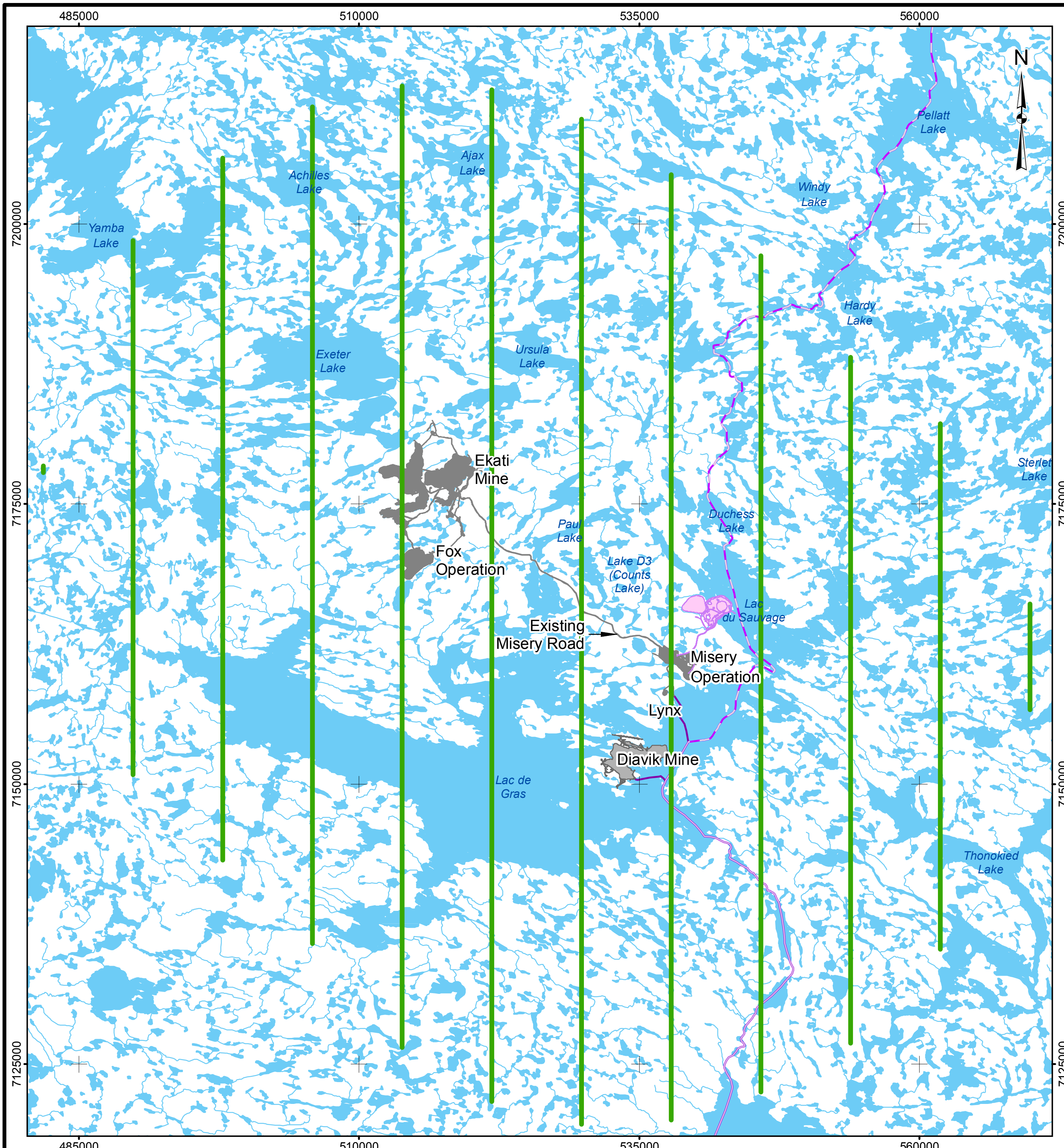
From 1995 to 1997, the Diavik Mine regional study area was approximately 1,200 $km^2$ (DDMI 1998). From 1998 to 2001, systematic surveys were flown in the Ekati Mine regional study area (approximately 1,600 $km^2$) (Rescan 2011). Beginning in 2002, survey transects were extended to include an area around the Ekati Mine and the southeastern shore of Lac de Gras (Rescan 2011). This new study area was used for aerial surveys at the Ekati and Diavik mines, and was approximately 2,800 $km^2$. In 2006, the Ekati Mine regional study area was increased to 5,425 $km^2$. The Diavik Mine study area increased to 1,870 $km^2$ in 2006, and to 2,867 $km^2$ in 2007. In 2009 and 2012, aerial surveys were jointly completed for the Ekati and Diavik mines for a regional study area of approximately 5,933 $km^2$, which constitutes the BSA (Map 12.2-1). Maps of previous survey areas are provided in Annex VII.

### *12.2.1.1.2 Caribou Behavioural Response Studies*

Information to determine whether the dominant behaviour of caribou groups (with and without calves) varies with distance to the mine (i.e., activity budgets) has been collected at the Ekati Mine since 1998 using an established monitoring program (BHP 1999). Observations of caribou groups at various distances from the mine, and group behaviours at specified time intervals, were recorded based on behavioural observations (scan surveys). From 2001 to 2009, the activity budget study was expanded to include recording of caribou groups' responses to stressors (Rescan 2012). From 2004 to 2008, increased effort was made to collect scan survey samples at greater than 7 km from the Ekati Mine (Rescan 2010). In 2010, the Ekati Mine opted to record caribou behaviours using focal sampling on a single animal (Rescan 2012). This focal sampling method continued until 2012.

Caribou behavioural responses to natural and human-caused stimuli at the Diavik Mine were documented from opportunistic observations from 1995 to 1997 (DDMI 1998). Additional observations of caribou response to human-caused stimuli were obtained during deflection trials completed in 1996 and 1997 (DDMI 1998). From 2003 to 2005, the Diavik Mine implemented opportunistic ground-based behaviour scanning surveys following protocols implemented at the Ekati Mine (DDMI 2006).

In 2009, the Ekati and Diavik mines worked collaboratively to increase effort at sites farther from and closer to the two mines. Diavik focused efforts in areas greater than 14 km from either mine (i.e., outside of the suggested ZOI) (DDMI 2010), and Ekati focused efforts in areas closer to the mine (Rescan 2010).




## LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY
- AERIAL SURVEY TRANSECT

10 0 10

SCALE 1:500,000 KILOMETRES

## REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

# CARIBOU AERIAL SURVEY TRANSECTS, EKATI AND DIAVIK MINES, 2009 AND 2012

Golder Associates

| | | | |
|---|---|---|---|
| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_060_GIS |
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN REV. 0 |
| GIS | ANK | 01/10/14 | |
| CHECK | JR | 01/10/14 | MAP 12.2-1 |
| REVIEW | LD | 01/10/14 | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_060_GIS.mxd

#### 12.2.1.1.3 Caribou Distribution Relative to Roads

Opportunistic surveys were completed at the Ekati Mine from 2001 to 2010 (Rescan 2011) to determine whether caribou groups with calves were distributed similarly to non-nursery groups relative to roads, and whether caribou group behaviours varied with distance from the road. From 2001 to 2003, records of survey distances were kept so that the number of caribou observed per distance surveyed (encounter rates) could be calculated. From 2004 to 2010, records of survey distances were not kept. Instead, when caribou were recorded within 200 metres (m) of the road, they were recorded in one of three distance categories: on the road, within 50 m of the edge of the road, or, within 50 to 200 m from the edge of the road. Only caribou within 200 m of the road were recorded.

#### 12.2.1.1.4 Permeability of Roads to Caribou

The permeability of roads to caribou was monitored by recording snow track patterns along the side of the Misery Road at the Ekati Mine during the northern migration. The objective of the study was to determine whether the Misery Road was a barrier to caribou movement, and whether the frequency of caribou crossing varied with factors such as traffic volume and snow bank height. Surveys were completed in late April and May from 2002 to 2010 (Rescan 2011). The entire Misery Road and the proposed Sable Road have been surveyed annually since 2004.

#### 12.2.1.1.5 Caribou Long Lake Containment Facility Monitoring

From 1999 to 2012, opportunistic monitoring for caribou at the Ekati Mine Long Lake Containment Facility (LLCF; a facility to receive and store fine processed kimberlite and waste water) was completed to determine the frequency of use, group size, group composition, and dominant group behaviours of caribou observed in the LLCF (ERM Rescan 2013a). Monitoring in 2011 and 2012 was completed using camera-based techniques (Section 12.2.1.1.6).

#### 12.2.1.1.6 Caribou Camera Monitoring Program

Camera-based monitoring of caribou at the Ekati Mine was implemented in 2011, 2012, and 2013 (ERM Rescan 2013b, 2014a). In 2011, 49 infrared motion-triggered cameras were deployed around the mine site, and 90 cameras were deployed in 2012 and 2013. Cameras were placed around project infrastructure such as road and fences to collect data on caribou numbers, movements, and behaviours around these mine structures. The majority of cameras were placed along the Misery Road (28, 55, and 45 for 2011, 2012, and 2013 respectively), and varying numbers were deployed on Pigeon Road, Sable Road, the LLCF, Waste Rock Storage Facility, Pigeon Stream Diversion Access Road, Pigeon Fence, and Beartooth Fence (ERM Rescan 2014a). The primary objectives of the camera monitoring program were the following:

- to determine and compare temporal trends in caribou abundance around the Ekati Mine site;
- to determine and compare which locations have the highest numbers of caribou, and which may be avoided;
- to determine and compare relative frequencies of behaviours in caribou among locations;
- to determine whether the structure of tundra roads deters caribou from crossing;
- to determine whether alert behaviours near the road are associated with traffic; and,
- to determine whether plastic fencing causes adverse behavioural reactions.

### *12.2.1.2 Gahcho Kué Project*

The Gahcho Kué Project is within the ESA for the Jay Project, and research and monitoring at Gahcho Kué is relevant in the description of the existing environment. Initial aerial reconnaissance surveys to document barren-ground caribou and caribou sign in the Gahcho Kué Project study area and along the Gahcho Kué winter access road route were completed in 1996 and 1998 (De Beers 2010). Additional aerial reconnaissance surveys were completed in the Gahcho Kué Project's regional and local study areas, and along the winter access road route from 1999 to 2003 (Table 12.2-2; Map 12.2-2). In 2004 and 2005, systematic aerial surveys were completed. Aerial surveys in 2004 did not have a fixed transect survey area (i.e., all animals that were seen were recorded). In 2005, the aerial surveys had a fixed width of 600 m on either side of the helicopter, following standard protocols at other diamond mine developments.

**Table 12.2-2 Barren-Ground Caribou Aerial Survey Dates in the Gahcho Kué Project Study Area, 1999 to 2005**

| Year | Date |
|---|---|
| 1999 | May 6 to 9; July 17 to 22; October 3 and 4 |
| 2000 | September 10; October 13 |
| 2001 | May 10; October 25 |
| 2002 | May 8; July 2 to August 31; September 25 |
| 2003 | May 13; August 4; October 4 |
| 2004 | May 4 to 7; May 26 to 28; October 8 and 9 |
| 2005 | March 28 to 31; April 30 to May 2; May 18 to 20; July 28 to 31; September 22 to 25 |

### *12.2.1.3 Snap Lake Mine*

The Snap Lake Diamond Mine (Snap Lake Mine) is within the ESA for the Project, and research and monitoring at Snap Lake Mine is relevant in the description of the existing environment. Systematic aerial surveys were completed in the Snap Lake Mine study area from 1999 to 2011 during the caribou post-calving period (Table 12.2-3; De Beers 2013). Seven transect lines, spaced 8 km apart, were flown in a north-south direction following a predetermined flight path using Global Positioning System coordinates. In 1999 and 2000, aerial transect surveys were unbounded (i.e., all animals observed were recorded), within an estimated 1 km on either side of the helicopter. Beginning in 2001, only caribou within 600 m of either side of the helicopter along a transect line were counted. Caribou observations off-transect were not recorded unless the group size was large (e.g., 1,000 animals). Off-transect observations were not included in the analyses.


## LEGEND

EXISTING PROJECT
WINTER ROAD
ESKER
TREELINE
WATERCOURSE
WATERBODY
SURVEY TRANSECT

10 0 10
SCALE 1:500,000 KILOMETRES

PROJECT
DOMINION DIAMOND
JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
**CARIBOU AERIAL SURVEY TRANSECTS, GAHCHO KUÉ PROJECT, 1999 TO 2005**

## REFERENCE

DE BEERS 2008
NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

Golder Associates

| | | | | |
|---|---|---|---|---|
| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_061_GIS | |
| DESIGN | LD | 17/01/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 01/10/14 | **MAP 12.2-2** | |
| CHECK | JR | 01/10/14 | | |
| REVIEW | LD | 01/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_061_GIS.mxd

**Table 12.2-3 Aerial Survey Dates During the Caribou Post-Calving Migrations in the Snap Lake Mine Study Area, 1999 to 2011**

| Year | Date |
|---|---|
| 1999 | July 21, 22, 23 |
| 2000 | July 21; August 17 |
| 2001 | August 8, 11, 16; October 24 |
| 2002 | July 23; August 2, 10; September 30 |
| 2003 | July 25, 29; September 27; October 17 |
| 2004 | July 28; September 17, 23 |
| 2005 | July 28; September 14; October 13, 21 |
| 2006 | September 19; November 10 |
| 2007 | September 18, 28; October 23 |
| 2008 | September 16 |
| 2009 | October 1 |
| 2010 | November 15 |
| 2011 | November 2 |

### 12.2.1.4 Government of the Northwest Territories

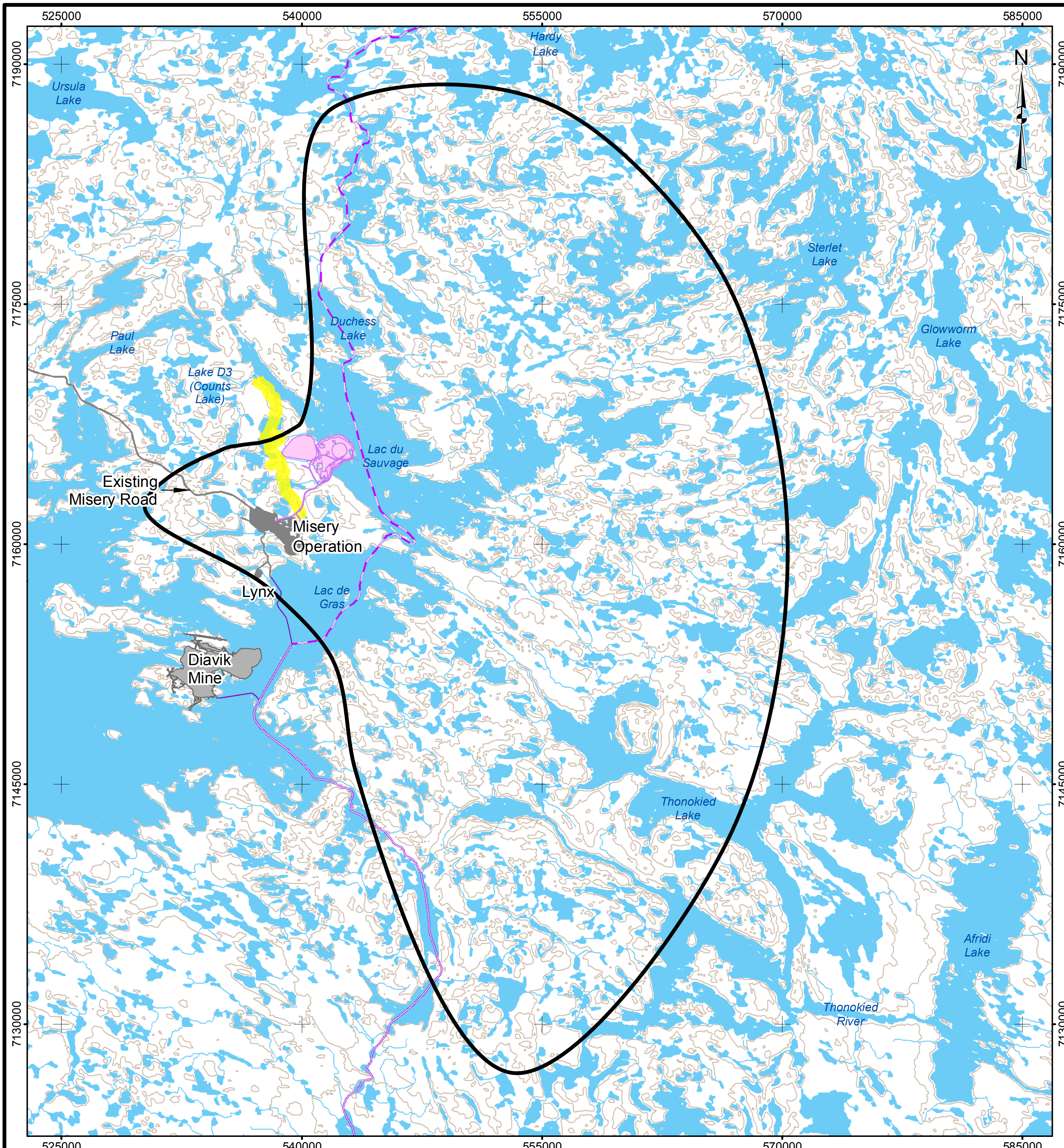
For the purposes of the DAR, the locations of satellite-collared cows from the Bathurst (April 1996 to October 2013), Beverly (April 1995 to October 2013), and Ahiak herds (March 2001 to October 2013), were used to describe the annual and seasonal movements for each herd (data courtesy of Environment and Natural Resources [ENR]).

#### 12.2.1.4.1 Mine-Related Incidents and Mortalities

Mine-related wildlife mortalities in the NWT are monitored in several ways. Personnel undergo environmental orientation and are required to report all wildlife incidents they observe. Environmental data collection programs also occur at the mine sites, such as wildlife monitoring, water quality sampling, and dust and vegetation monitoring programs. Any wildlife mortalities located during these monitoring or sampling events are reported to environmental personnel.

### 12.2.1.5 Jay Project Baseline Surveys

An aerial survey was completed on August 12, 2013 to provide a high-level overview of historical caribou trails and deflection features (e.g., large lakes, rugged habitat, and development infrastructure) that may influence caribou migration routes in the Lac de Gras region. The survey was completed around Lac du Sauvage with approximate boundaries at Lake Thoynoykyed, Sterlet Lake, and Hardy Lake (to the south, east, and north, respectively) (Map 12.2-3). The survey was completed using a helicopter that flew approximately 80 kilometres per hour (km/h) at 400 m above ground level.




## LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 m INTERVAL)
- WATERCOURSE
- WATERBODY
- ESKER SURVEY
- RECONNAISSANCE SURVEY AREA

6 0 6

SCALE 1:350,000 KM

## NOTE

LOCATION OF PATHWAYS, OBSTACLES AND ESKERS SURVEYED DURING THE CARNIVORE DEN SURVEYS

## REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

# RECONNAISSANCE SURVEY AREA FOR HISTORICAL CARIBOU TRAILS, 2013

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_063_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 01/10/14 | MAP 12.2-3 | |
| CHECK | JR | 01/10/14 | | |
| REVIEW | LD | 01/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_063_GIS.mxd

DOMINION DIAMOND

## 12.2.2 Results

### *12.2.2.1 Caribou Distribution and Abundance*

Satellite collar data indicates that the Bathurst population has the greatest likelihood of interacting with the Project. Of approximately 67,010 satellite locations collected from January 1996 through October 2013 for 598 collared cows in the Bathurst herd, 213 collared cows (and 3,068 point locations) were located in the BSA during the all seasons (Table 12.2-4). Collared caribou were most commonly recorded in the BSA during the spring migration, post-calving, and autumn migration periods (Table 12.2-4). Caribou have also been commonly observed during aerial surveys in the BSA during the post-calving period (Map 12.2-4). Few satellite-collared caribou are present in the BSA during the calving and winter periods (Table 12.2-4).

The 394 collared cows from the Ahiak herd had a total of 73,837point locations from March 2001 through October 2013 (Table 12.2-4). Of these 394 collared caribou, 3 individuals (and 11 point locations) were recorded in the BSA during the spring migration period, and 1 caribou (2 point locations) was recorded during the autumn migration period (Table 12.2-4). No collared animals were located in the BSA during the calving, post-calving, and winter periods.

Based on 9,003 point locations for 118 collared cows from January 1995 through October 2013, no collared individuals from the Beverly herd have been recorded in the BSA during any season (Table 12.2-4).

Historical caribou trails observed during the aerial reconnaissance survey for the Project are presented in Map 12.2-5. Overall, there is a high level of spatial and temporal variability in the distribution and abundance of caribou because barren-ground herds typically winter south of the treeline and calve in the barren-ground tundra. During the post-calving period, caribou have been observed throughout the survey areas (Map 12.2-4). For example, from 1995 to 1997, caribou numbers in the Diavik study area ranged from an estimated 0 to 100,000 individuals among seasons (DDMI 1998). From 2002 to 2009, the number of caribou observed in the Diavik study area was lower than recorded in 1996 and 1997 (DDMI 2010). Since 1999, the number of caribou observed per area surveyed (mean density) in the Snap Lake Mine study area ranged from 0.00 to 3.62 caribou per $km^2$ during the post-calving migration (De Beers 2013). At the Ekati Mine, encounter rates of caribou with motion-triggered remote cameras were highest in August and October (ERM Rescan 2013b).

**Table 12.2-4 Number of Collared Caribou and Number of Locations within the Baseline Study Area, by Herd and Season from 1995 to 2013**

| Herd | Season[(a)] | Number Collared Caribou in BSA | Total Number of Collared Caribou | Number of Satellite Point Locations in the BSA | Total Number of Satellite Point Locations |
|---|---|---|---|---|---|
| Bathurst | spring | 52 | 120 | 89 | 4,257 |
| | calving | 4 | 114 | 9 | 3,963 |
| | post calving | 77 | 116 | 2,085 | 31,616 |
| | autumn | 68 | 108 | 833 | 5,354 |
| | winter | 12 | 140 | 52 | 21,820 |
| | **Total** | **213** | **598** | **3,068** | **67,010** |

**Table 12.2-4 Number of Collared Caribou and Number of Locations within the Baseline Study Area, by Herd and Season from 1995 to 2013**

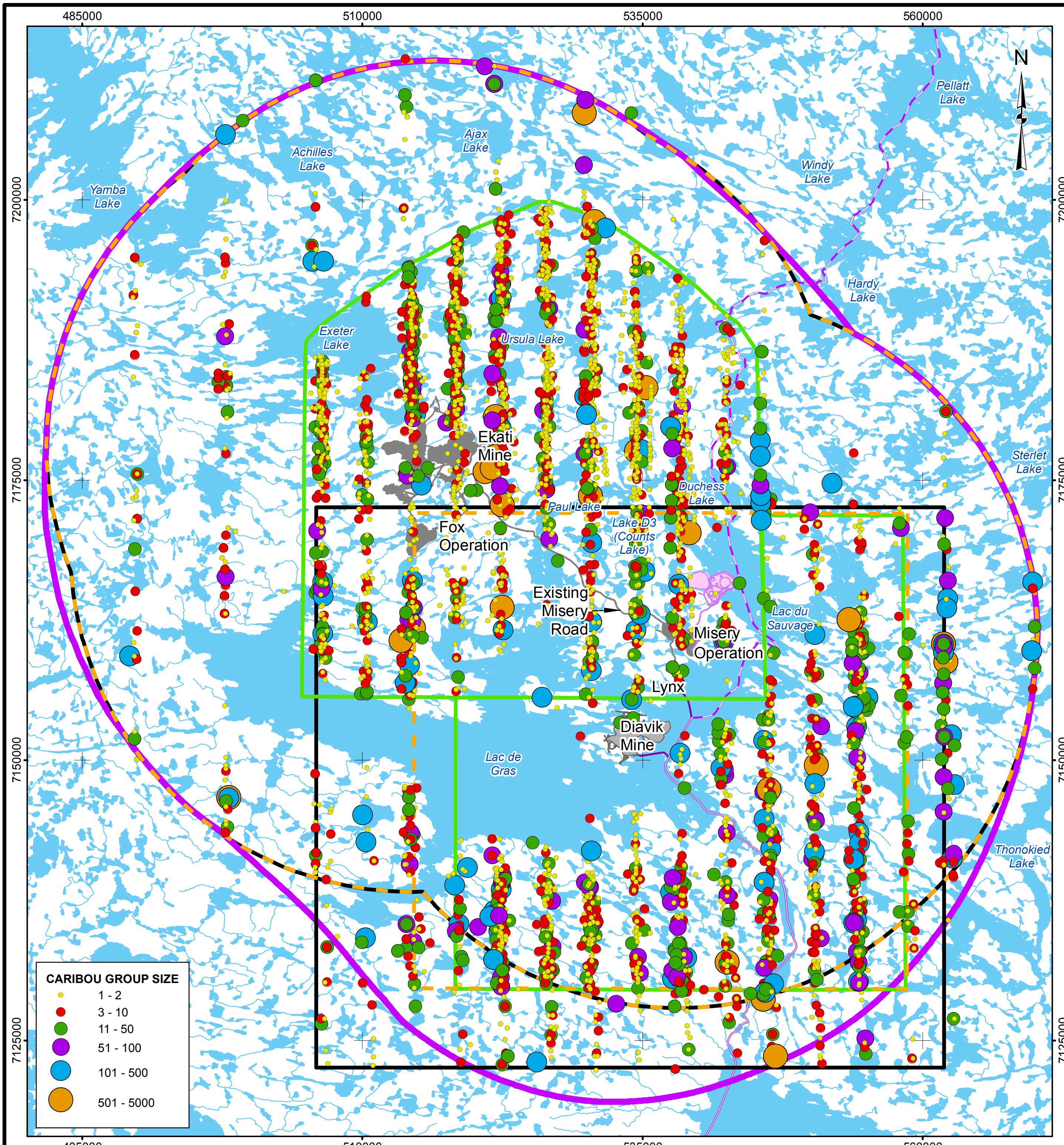
| Herd | Season[a] | Number Collared Caribou in BSA | Total Number of Collared Caribou | Number of Satellite Point Locations in the BSA | Total Number of Satellite Point Locations |
|---|---|---|---|---|---|
| Ahiak | spring | 3 | 77 | 11 | 6,652 |
| | calving | 0 | 78 | 0 | 3,605 |
| | post calving | 0 | 79 | 0 | 19,710 |
| | autumn | 1 | 75 | 2 | 10,978 |
| | winter | 0 | 85 | 0 | 32,892 |
| | **Total** | **4** | **394** | **13** | **73,837** |
| Beverly | spring | 0 | 39 | 0 | 1,916 |
| | calving | 0 | 13 | 0 | 315 |
| | post calving | 0 | 12 | 0 | 1,251 |
| | autumn | 0 | 11 | 0 | 628 |
| | winter | 0 | 43 | 0 | 4,893 |
| | **Total** | **0** | **118** | **0** | **9,003** |

a) spring = May 1 to May 31; calving = June 1 to June 14; post calving = June 15 to August 31; autumn = September 1 to October 31; winter = November 1 to April 30 (ENR 2009).

BSA = baseline study area.

In addition to natural variability, evidence suggests that caribou herds change their distribution around diamond mine developments (Boulanger et al. 2004, 2012; Johnson et al. 2005; Rescan 2007; Golder 2011a). Caribou are more likely to occur further from developments than closer to developments. Analysis of satellite collar data suggested that mines and other major developments may have a ZOI of up to 33 km (Johnson et al. 2005). A study using aerial survey and satellite-collar data collected around the Diavik, Ekati, and Snap Lake mines estimated a ZOI that may be 16 to 50 km (Boulanger et al. 2004). Golder (2011a) detected zones of influence ranging from 12 to 40 km around the Diavik mine and Lac de Gras. The ZOI around the Diavik mine site may be confounded by the presence of open water around East Island because caribou avoid this area during the open-water season. There was no detected relationship between the extent of the ZOI and the level of activity at the Diavik Mine (Golder 2011a). At the smaller Snap Lake Mine, a ZOI of 6.5 to 28 km was detected (Golder 2008a; Boulanger et al. 2009). The ZOI around the Snap Lake Mine increased with time from baseline through construction (Golder 2008a). Using radio-collar and aerial survey data, the most recent analysis showed that the ZOI around the Ekati-Diavik mine complex varies from 11 to 14 km (Boulanger et al. 2012).

Data collected from 1995 to 2009 at the Ekati Mine suggest that the probability of observing a caribou in a transect cell during the post-calving migration increases as distance from the mine increases (Rescan 2010). Generally, the Ekati Mine seems to have a larger influence on the distribution of nursery groups than on non-nursery groups (Rescan 2010).




## LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- WATERCOURSE
- WATERBODY
- DIAVIK AND EKATI WILDLIFE STUDY AREAS, 1998 - 2005
- DIAVIK AND EKATI WILDLIFE STUDY AREAS, 2006
- DIAVIK AND EKATI WILDLIFE STUDY AREAS, 2007 - 2008
- DIAVIK AND EKATI WILDLIFE STUDY AREA, 2009

10 0 10

SCALE 1:500,000 KILOMETRES

## REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

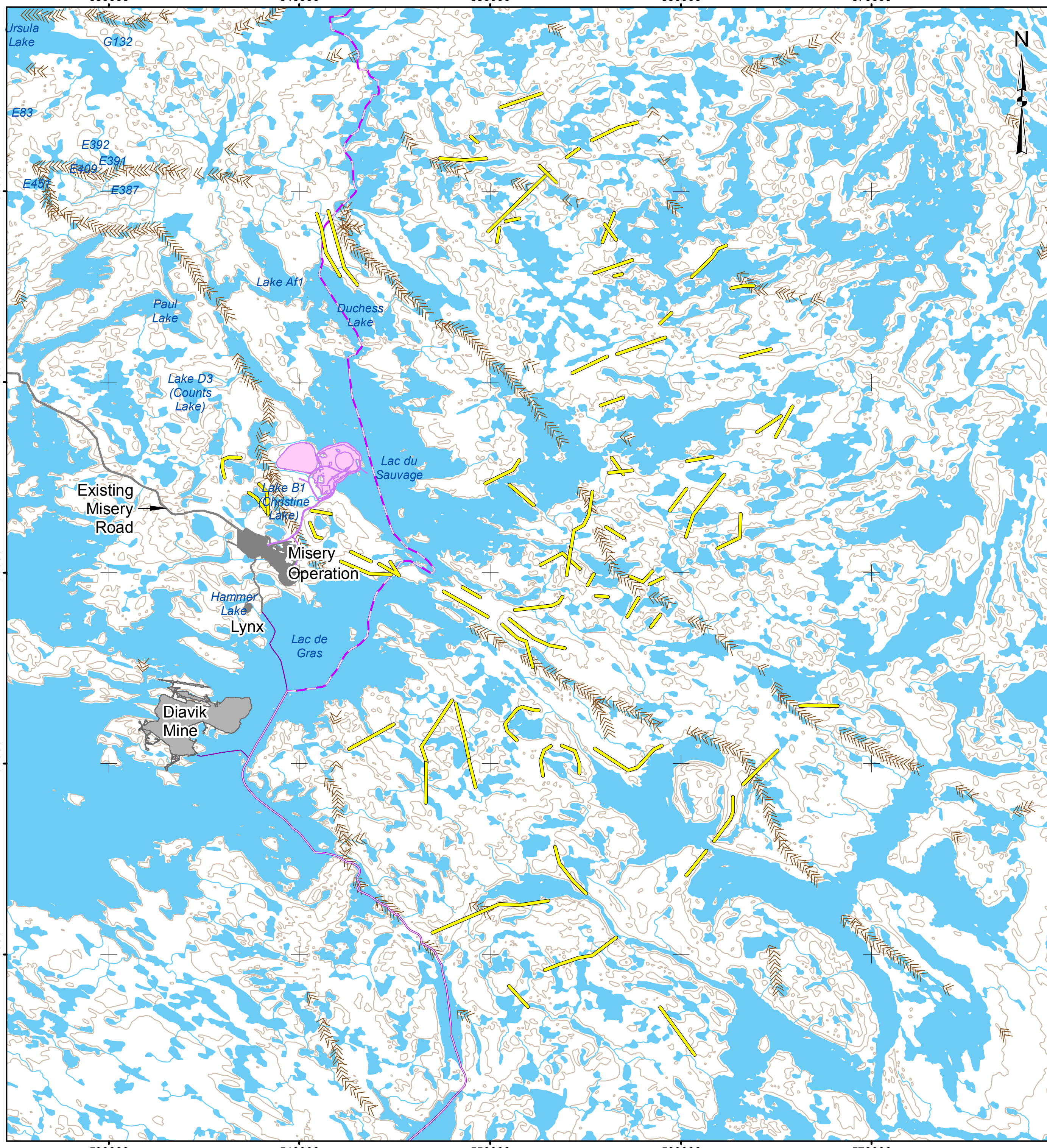
TITLE

**DISTRIBUTION AND SIZE OF CARIBOU GROUPS OBSERVED DURING POST-CALVING SEASON SURVEYS 1998 TO 2009**

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_064_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 02/10/14 | | |
| CHECK | JR | 02/10/14 | **MAP 12.2-4** | |
| REVIEW | LD | 02/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_064_GIS.mxd




G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_095_GIS.mxd

## LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- ELEVATION CONTOUR (20 M INTERVAL)
- ESKER
- WATERCOURSE
- WATERBODY
- CARIBOU TRAIL

5 0 5

SCALE 1:300,000 KM

## REFERENCE

CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

WILDLIFE BASELINE REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

# HISTORICAL CARIBOU TRAILS OBSERVED DURING AERIAL RECONNAISSANCE SURVEY, 2013

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_095_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 20/08/14 | SCALE AS SHOWN | REV. 0 |
| GIS | TN | 02/10/14 | MAP 12.2-5 | |
| CHECK | JR | 02/10/14 | | |
| REVIEW | LD | 02/10/14 | | |

### 12.2.2.2 Caribou Behaviour and Habitat Use

Data from satellite-collared caribou revealed that caribou regularly travel through the BSA during the spring and autumn (Golder 2008b, 2011a). Data collected from satellite-collared caribou for the Diavik Mine suggest that caribou can travel an average of 9 to 11 km per day (straight-line distance) (DDMI 1998). The straight-line travel routes of collared caribou seem to be highly correlated with caribou travel routes and movement corridors that were observed and synthesized from aerial survey data. During spring migration, caribou in the Diavik Mine study area were observed to follow the shorelines of large lakes, and caribou crossed lakes between the closest points of land (DDMI 1998).

Habitat selection and behaviour of barren-ground caribou are frequently the result of their response to environmental conditions; therefore, caribou can be found in a variety of habitat types at any one time (Case et al. 1996). The selection of habitat appears to be related to food availability, ease of travel, relief from insects, and predation (Curatolo 1975). Caribou likely select habitats at several spatial scales. At the scale of the seasonal range, caribou select habitats dominated by lichen, heath tundra, and rock vegetation types (Johnson et al. 2005). The Bathurst caribou herd has been found to prefer lichen heath habitat (Griffith et al. 2002). Cows select calving grounds based on the potential for high levels of green plant biomass (Griffith et al. 2002).

At a smaller scale, heath tundra, heath tundra/boulder-bedrock, and riparian shrub appear to be the most preferred habitat types during the northern and post-calving migration periods (BHP Billiton 2004; Golder 2008a,b). Feeding and resting behaviours (from aerial survey observations at the Gahcho Kué Project) were more common in riparian shrub and sedge wetland habitats (De Beers 2010). Frozen lakes and eskers may be important as movement corridors during the northern migration (De Beers 2010). Large lakes also appear to influence caribou distribution during the summer period because animals tend to move around large, open bodies of water (De Beers 2010).

Analysis of data collected at the Gahcho Kué Project indicated that caribou were found more frequently than expected on frozen lakes during the northern migration, which were used for travel through the study area (Chi-square [$\chi^2$] = 22.84, $P$ = 0.04) (De Beers 2010). During summer, caribou used bog, heath tundra, and tussock-hummock habitats in higher proportion than their availability ($\chi^2$ =62.58, $P$ <0.01). In the fall, caribou selected heath tundra, sedge wetlands, and tussock-hummock habitats relative to their availability ($\chi^2$ =86.95, $P$ <0.01). Pellet-group densities in the Diavik Mine study area were greatest in heath tundra, esker sides, sedge associations, tall shrub, and esker tops (DDMI 1998).

Caribou are also known to use artificial habitats created by mine structures such as roads and mine rock piles. These structures may provide a means of avoiding insect harassment, because caribou have been observed bedding or resting on these structures (Gunn et al. 1998; BHP Billiton 2004; Rescan 2007). Since 1999, there have been 622 caribou observed during 19.0% of the 487 surveys within the LLCF at the Ekati Mine (Rescan 2012). Most observations (89.0%) were of small groups (less than or equal to five individuals) travelling through the area (52.3% of groups). Caribou observations at the Ekati Mine (2001 to 2010) show that single caribou are more likely to occur within 50 m of road berms, while nursery and non-nursery groups are more likely to be observed within 50 to 200 m of road berms (Rescan 2012). Single animals have been observed on roads at the Ekati Mine 20.7% of the time, while nursery and non-nursery groups have been observed on roads 14.0% and 10.5% of the time, respectively.

From 2002 to 2011, caribou snow tracks recorded along the Misery Road in April and May deflected from the road approximately 57% of the time (Rescan 2012). Snow bank height appears to have the largest influence on caribou road crossings, and groups were more likely to cross the road than individuals. However, because only tracks within metres of the road were recorded, it cannot be determined from these data whether these deflections represented caribou that did not cross the road, or caribou that chose a different location to cross the road. This monitoring initiative was replaced with the remote camera monitoring in 2011 (ERM Rescan 2014a). From wildlife camera monitoring results, when caribou encountered Misery Road, less than 1% of encounters resulted in a deflection; Misery Road is not an impermeable barrier to caribou movement (ERM Rescan 2014a). The key factor affecting crossings appears to be berm height, and not traffic volume or maximum road height (ERM Rescan 2014a).

Studies at the Diavik Mine showed that the majority of caribou observed moved away from the stimuli when they were approached by humans on foot (within 100 to 200 m) or were exposed to noise from aircraft takeoffs at the camp (DDMI 1998). Alarm responses (moving away from the stimuli) were documented when noise stimuli were within 75 m of caribou groups (DDMI 1998). Caribou expressed lower behaviour response intensity to visual stimuli (i.e., white cloth flutters and a flashing construction light); most responses were animals becoming more alert but not moving away from the stimuli.
At the Ekati Mine caribou generally become more alert but do not move away from stimuli associated with humans at camps, exploration camp infrastructure, and vehicles operating on roads (Rescan 2012). Nursery groups are more likely to respond to anthropogenic (man-made) stressors than non-nursery groups (Rescan 2007, 2012).

Activity budgets of caribou are influenced by environmental and anthropogenic variables. Insect harassment is known to reduce foraging and influence body condition for caribou (Gunn et al. 2001; Weladji and Holand 2003). However, not all studies on caribou behaviour and insect abundance have found this result (Golder 2011a). Oestrid flies appear to have the greatest influence on caribou behaviour, although time spent feeding and lying was reduced to the greatest degree when oestrid flies, black flies, and mosquitos were all present (Witter et al. 2012). More caribou were observed walking than feeding when insect abundance was high, but feeding intensity (ratio of time eating to total time eating and searching) remained similar regardless of insect abundance. Feeding intensity appeared to be related more to changes in vegetation abundance (Witter et al. 2012). Although sample sizes are small, studies at the Ekati Mine suggest that caribou are reasonably tolerant of human activity around mines because males and females were observed to be resting (i.e., bedded or feeding) 62% and 68% of the time, respectively, during focal behaviour surveys (Rescan 2012).

### 12.2.2.3 Caribou Population Characteristics

Barren-ground caribou herds in the NWT appeared to decline from the 1990s to about 2010, with some herds experiencing declines since the 1970s (BQCMB 2008, 2009; Fisher et al. 2009; Vors and Boyce 2009). As a result, herds of barren-ground caribou in the NWT (except Peary and Dolphin-Union caribou) are ranked as “sensitive” in the NWT (NWT Infobase 2012). Barren-ground caribou are not listed under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2013) or *Species at Risk Act* (SARA 2012). The number of animals in barren-ground caribou herds increase and decrease at relatively regular intervals, for example, every 30 to 60 years (Zalatan et al. 2006; GNWT-ENR 2013). Although these natural fluctuations in herd size appear to be linked to changes in climatic patterns and winter range quality (Ferguson and Messier 2000; Weladji and Holand 2003; Gunn 2009; Vors and Boyce 2009), the exact mechanisms responsible for generating these population cycles are unknown.

The Bathurst caribou herd has declined from 472,000 individuals in 1986 to 31,900 individuals in 2010 (decline of 93.2% over 26 years) (GNWT-ENR 2013). Photo surveys completed in 2012 suggest that the Bathurst herd increased to 35,000 individuals (increase of 9.7% since 2010; Boulanger et al. 2014a). Reconnaissance surveys and calving photo surveys flown over the past 9 years indicated a decline from 2006 to 2009, and a stable trend from 2009 to 2012. In 2013, a reconnaissance survey suggested a small increase in caribou number, which may have been an overestimate (Boulanger et al. 2014b). A reconnaissance survey flown in June 2014 suggests a large decline in the Bathurst from 2012 (14,390 ± 6,109 animals) to 2014 (3,594 ± 2,133). Because of the differences in sampling area covered among previous and recent reconnaissance surveys, estimates of abundance and trends are imprecise (Boulanger et al. 2014b). A photo survey planned for the summer of 2015 by the GNWT will provide more precise estimates of size and trend for the herd.

The Government of Nunavut carried out calving ground surveys for the Beverly and Ahiak caribou herds in 2011. The population estimates are 124,000 for the Beverly herd, and 83,300 for the Ahiak herd (GNWT 2013a). Other herds in the NWT have shown similar trends. Although the Porcupine herd experienced a 23% decrease from 1992 to 2001 (from 160,000 individuals to 123,000 individuals), surveys completed in 2010 suggest that this population is increasing (GNWT-ENR 2013). The Cape Bathurst, Bluenose East, and Bluenose West herds also seem to be stable or increasing in recent years (based on surveys completed in 2010 and 2012). Reduced fecundity and adult survival have been cited as contributing factors to declines in herd size (Boulanger and Gunn 2007; Nishi et al. 2007; Boulanger et al. 2011). During surveys on the calving grounds of the Beverly and Qamanirjuaq herds, for every 100 cows there were estimated to be 15 and 20 calves, respectively, which is well below the usual 80 calves per 100 cows (BQCMB 2008).

Using modelling techniques and data collected from 1996 to 2003, Boulanger and Gunn (2007) estimated annual survival rates of caribou as follows: female adults = 0.842; female yearlings (age 1) = 0.842; and, female calves (i.e., young-of-the-year) = 0.259. Male adult survival was estimated to be 0.730. Estimates of survival rates for male yearlings and calves were not presented in Boulanger and Gunn (2007). Fecundity, defined as the average number of calves produced for each sex, and a function of adult survival, was 0.45. The decline of the Bathurst caribou herd from 1985 to 2010 appears to be most strongly correlated with directional trends in calf survival, fecundity, and adult female survival (Boulanger et al. 2011).

Factors that may influence adult and calf survival include insects, climate change, hunting, food quantity and quality, and industrial development. Direct and indirect loss of habitat from human development footprints and their associated zones of influence have likely resulted in changes to the carrying capacity of the landscape (Johnson et al. 2005). There could also be energy costs associated with sensory disturbance events (e.g., noise, presence of humans, smells) (Tyler 1991). Although a single encounter with disturbance (i.e., loud noise) is unlikely to cause an energy deficit for an animal, the effect of exposure to disturbance could be proportional to the number of times an individual encounters disturbance events (Bradshaw et al. 1998).

Effects from human developments may be confounded by effects with natural factors such as insect pest outbreaks and climate change. Caribou that experience high levels of insect harassment generally have poor body condition (Weladji and Holland 2003) because they spend less time foraging and more time being active (Toupin et al. 1996; Łutsel K'e Dené Elders and Land-Users et al. 2003; Witter et al. 2012). However, even though time spent feeding is less when insect abundance is high, feeding intensity seems to be similar to that under low insect abundance (Witter et al. 2012).

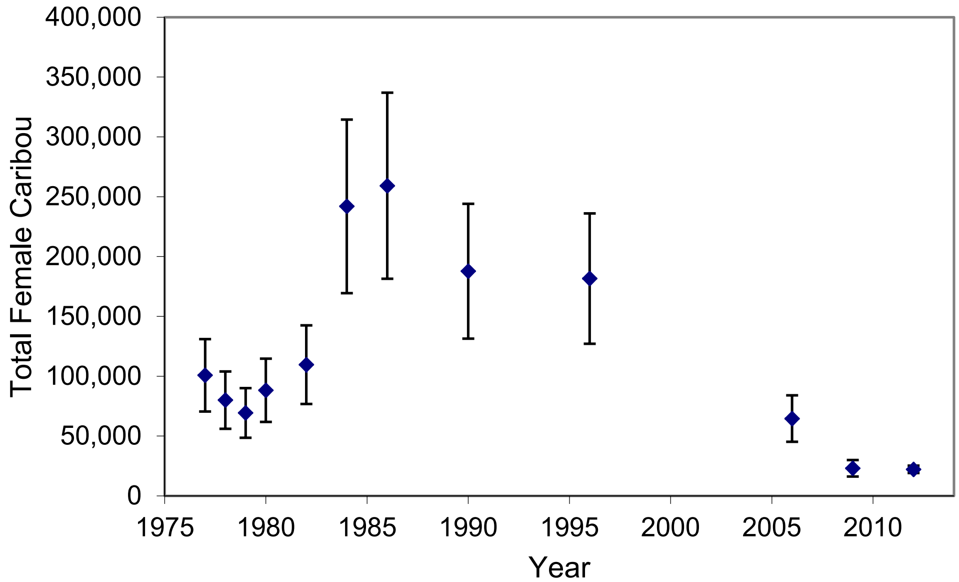
Climate warming is expected to increase the duration and intensity of insect harassment on caribou because of earlier insect emergence, greater insect abundance, and increased insect distribution (Weladji and Holland 2003; Vors and Boyce 2009). Climate change is also expected to increase the frequency and intensity of wildfires and enable plants to expand their ranges northward. As fires increase and plants move north, moose and wolves may also increase their northern distribution, which may negatively affect caribou populations and distributions (Sharma et al. 2009). Traditional knowledge also contends that fire frequency and intensity affects caribou numbers and distribution (Kendrick et al. 2005).

Climate change is also likely to lead to earlier plant emergence. Because plants are most nutritious and digestible soon after emergence, it is important for caribou to access these resources as close to plant emergence as possible; however, caribou migrations are mainly cued by day length (Post and Forchammer 2008). Therefore, as the climate becomes warmer, caribou migrations may become asynchronous with plant emergence, which may lead to a decline in reproductive success, as observed in Greenland (Post and Forchammer 2008).

Caribou herd size declines may also be caused by commercial and subsistence hunting (Boulanger and Gunn 2007; Boulanger et al. 2011). However, demographic models suggest that reduced levels of hunting generated only a slight increase in adult survival (3%), which is not enough to produce positive population growth (Boulanger and Gunn 2007). The effects of hunting on the Bathurst caribou herd decline cannot be determined with accuracy because of limited information available on predation, and the observed variation in productivity that contributed to the declining trend (Boulanger et al. 2011).

Density-dependence may be an important factor in caribou population dynamics (Tews et al. 2007). Density-dependence occurs when the growth rate of a population decreases as its density increases. In certain cases, growth rates decrease because of declining forage resources that cause decreases in survival and/or reproduction. This mechanism can lead to cyclical trends in abundance, starting when foraging levels surpass a critical level for maintenance of population size, resulting in either gradual reductions in population growth or abrupt population declines. Temporal data on population size in Case et al. (1996), combined with more recent information from Boulanger et al. (2011) and Government of the Northwest Territories (GNWT) surveys in 2010 and 2012 (Boulanger et al. 2014a), clearly show cyclical trends in abundance of Bathurst caribou from 1976 to 2012 (Figure 12.2-1). Thus, density-dependence is one possible mechanism that may influence caribou populations.

**Figure 12.2-1 Temporal Trend in Number of Female Caribou from the Bathurst Herd, 1976 to 2012**




Note: Values from 1977 to 1984 are from Case et al. (1996), values from 1986 to 2006 are from Boulanger and Gunn (2007), 2009 value is from Adamczewski et al. (2009), and 2012 value is from Boulanger et al. (2014a); values from 1997 to 1980 based on a visual census, whereas values after 1980 based on a photograph method.

### 12.2.2.4 Harvesting and Development

Historical harvest estimates are presented in Table 12.2-5, including harvest estimates from General Hunting Licence holders, resident hunters and non-resident/non-resident alien hunters. It is assumed that most of the harvest reported in the Dogrib Harvest Study was Bathurst caribou, as recent satellite collar studies indicate some overlap in winter with Bluenose-East caribou to the west and Ahiak caribou to the east (Adamczewski et al. 2009). The data show a gradual increase in the number of caribou harvested by resident hunters, and the initiation and growth of the sport hunting industry.

**Table 12.2-5 Estimates of Bathurst Caribou Harvest, 1982 o 1995**

| Harvest Year Ending | Dogrib Harvest Study[(a)] | Resident Hunters[(b)] | Non-Resident/ Non-Resident Alien[(b)] |
|---|---|---|---|
| 1982 | – | 250 | 2 |
| 1983 | – | 389 | 14 |
| 1984 | – | 924 | 24 |
| 1985 | – | 348 | 57 |
| 1986 | – | 432 | 67 |
| 1987 | – | 1,065 | 165 |
| 1988 | 7,924 | 1,905 | 291 |
| 1989 | 8,585 | 1,437 | 349 |
| 1990 | 17,220 | 1,547 | 227 |
| 1991 | 21,699 | 2,004 | 180 |
| 1992 | 18,731 | 1,469 | 343 |
| 1993 | 20,819 | 2,143 | 517 |
| 1994 | – | 1,238 | 409 |
| 1995 | – | 1,668 | 574 |

a) Source: Adamczewski et al. (2009).
b) Source: Case et al. (1996).
– = no data.

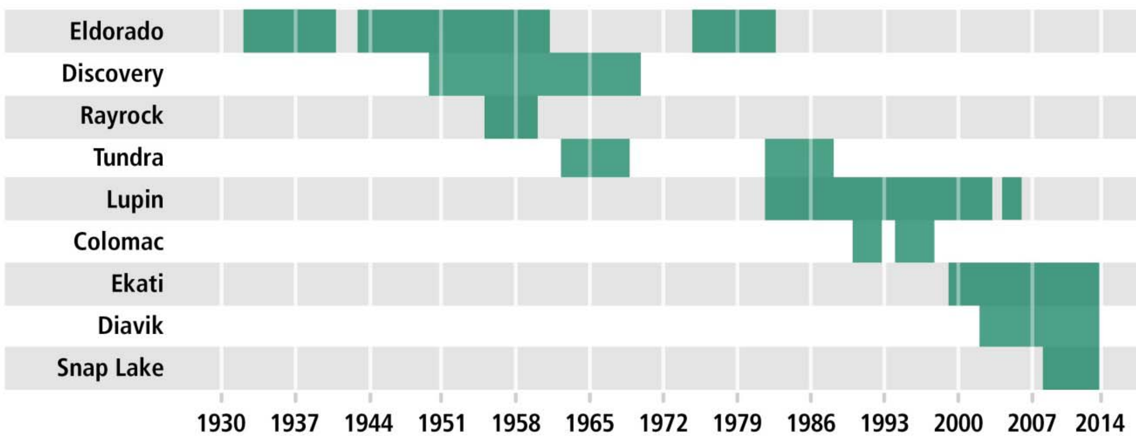
Non-Aboriginal harvest of caribou is regulated by GNWT-ENR. Historically, resident hunters were allowed to harvest up to five barren-ground caribou each year. The resident harvest occurred in two peaks: one in the fall when the caribou are near the treeline (August 15 to November 15), and another in winter when the herd is accessible by ice road for part of the section (November 15 to April 30). Non-resident hunters could harvest a maximum of two caribou per year (August 15 to November 30 in the North Slave region), and must obtain the services of a licensed outfitter.

Beginning January 1, 2010, barren-ground caribou commercial/meat tag, resident, and non-resident harvesting was closed in the North Slave and South Slave regions, and all hunting was closed in a new no-hunting conservation zone established north of Yellowknife where the Bathurst herd winters. The new zone included the Tibbitt to Contwoyto Winter Road and all diamond mines in the NWT, including the Project. Before these emergency measures, tags for sport hunters had been reduced, and tags for resident hunters had been reduced from five tags per resident hunter to two, with a preference for bulls.

Harvest restrictions as recommended by the Wek'èezhìi Renewable Resources Board were in effect for the 2010 to 2014 harvest seasons. This restriction includes 150 hunting tags for the Tłı̨chǫ people and 150 for the Yellowknives Dene First Nation (GNWT 2012). A joint proposal is being developed collaboratively with the Tłı̨chǫ Government on management actions for the herd for 2012 to 2016 and beyond (GNWT 2013b).

Many mines have been developed within the range of the Bathurst herd since the 1930s, although several of these mines were small operations that are poorly documented. The mines shown in Figure 12.2-2 met the minimum criteria of having had permanent airstrips, winter road access, and year-round operations. Among these nine operations, there has been almost continual mining in the Bathurst range, except for a short time in the early 1970s.

**Figure 12.2-2 Mining Activity Within or Near the Range of the Bathurst Caribou Herd Since 1930**




Other activities have also occurred in the Bathurst range. The mines shown in Figure 12.2-2 required winter access roads connected to the Tibbitt to Contwoyto Winter Road (TCWR). The TCWR has been in operation annually from 1982 to 2014, and was first built to support the Lupin Mine and other exploration activities. Sport hunting camps for caribou were also introduced in the early 1980s, and quickly expanded into an important tourism industry with more than eight camps harvesting over 500 bull caribou. Mineral exploration continues to be the most common permitted land use activity in the Bathurst range, and has included small tent camps to bulk sample operations. Exploration increased substantially from 2000 through 2008, and has declined since 2009. Other permitted activities included communication systems, quarries, staging areas, and hunting and fishing camps. Unfortunately, it is difficult to extract from these data a clear picture of the resulting disturbance to caribou, because there are no records on the seasonality of these activities, and whether they were active for the full duration of the land use permit.

##### *12.2.2.4.1 Mine-Related Incidents and Mortalities*

Caribou incidents and mortality that have occurred at the Diavik, Ekati, and Snap Lake mines since 1996, and are summarized in Table 12.2-6. Incidents include all occasions when there was an interaction between the mine and a caribou, and action was required (e.g., deterrent). An incident does not include mortality. The cause of wildlife mortality is clear for cases where problem wildlife are deliberately destroyed, or when an accidental event was witnessed. In other cases, such as when an animal is found dead within the mine property with no physical injury, the cause of death (natural or mine-related) may not be known.

##### *12.2.2.4.2 Intentionally Destroyed*

In 2001, an adult male caribou, which had not moved for several days, was destroyed at the Ekati Mine. This caribou had been repeatedly observed attempting to stand, but was not able to do so for more than a few seconds. After several days of not moving, and following consultation with ENR (then the Department of Resources Wildlife and Economic Development), the caribou was destroyed. A necropsy did not reveal any possible causes for the condition.

One female caribou was intentionally destroyed at the Ekati Mine in 2011. The individual consistently returned to forage adjacent to the airstrip, despite numerous attempts to deter it from the area. The individual was destroyed after consultation with the ENR, and the meat was distributed to nearby communities.

##### *12.2.2.4.3 Non-Intentionally Destroyed*

Ten non-intentional mine-related caribou deaths have been reported for the three developments since 1996. Three caribou died after becoming stuck in sediments during the dewatering of King Pond on the Ekati Mine site (Rescan 2012). One caribou was found dead, entangled in the electric fence around the Ekati airstrip in 2004; the exact cause of death was unclear because there was evidence of wolf predation that could have occurred before, during, or after the caribou became entangled in the fence. In 2009, four caribou died after becoming entangled in the Ekati Mine airstrip fence. In 2010, one caribou died after becoming entangled in the Ekati airstrip fence. The fence around the airstrip was replaced in August 2010 with a construction and safety barrier fence to avoid further fence-related caribou mortalities at the airstrip. One caribou was unintentionally killed at the Diavik Mine site in 2004 after becoming entangled in an electric fence that surrounded the Traditional Knowledge camp and was killed by a grizzly bear.

##### *12.2.2.4.4 Found Dead*

Eighty caribou have been found dead on the Ekati and Diavik mine sites since 1996 (Table 12.2-6). Most of these caribou were assumed to have been killed by wolves, although the exact cause of death could not always be determined.

DOMINION DIAMOND

**Table 12.2-6 Caribou Incidents and Mortality at the Ekati, Diavik, and Snap Lake Mines, 1996 to 2013**

| Site | Year | Phase | Species | Mortalities | | | Other Incidents[d] |
|---|---|---|---|---|---|---|---|
| | | | | Intentional[a] | Non-Intentional[b] | Found Dead[c] | |
| Diavik Mine[e] | 1996 to 1999 | Exploration | Caribou | — | — | 8 | — |
| | 2000 | Construction | Caribou | — | — | 7 | — |
| | 2001 | Construction | Caribou | — | — | 1 | — |
| | 2002 | Construction | Caribou | — | — | 1 | — |
| | 2003 | Production | no incidents | — | — | — | — |
| | 2004 | Production | Caribou | — | 1 | 2 | — |
| | 2005 | Production | no incidents | — | — | — | — |
| | 2006 | Production | no incidents | — | — | — | — |
| | 2007 | Production | Caribou | — | — | 1 | — |
| | 2008 | Production | no incidents | — | — | — | — |
| | 2009 | Production | no incidents | — | — | — | — |
| | 2010 | Production | no incidents | — | — | — | — |
| | 2011 | Production | Caribou | — | — | 1 | — |
| | 2012 | Production | Caribou | — | — | 1 | — |
| | 2013 | Production | Caribou | — | — | 1 | — |
| Ekati Mine[f] | 1998 to 1999 | Construction-Production | Caribou | — | — | — | 3 |
| | 2000 | Production | no incidents | — | — | — | — |
| | 2001 | Production | Caribou | 1 | — | 6 | — |
| | 2002 | Production | Caribou | — | 1 | 12 | — |
| | 2003 | Production | Caribou | — | 1 | 5 | — |
| | 2004 | Production | Caribou | — | 1 | 6 | — |
| | 2005 | Production | Caribou | — | — | 3 | 1 |
| | 2006 | Production | Caribou | — | — | 5 | 2 |
| | 2007 | Production | Caribou | — | — | 2 | 1 |
| | 2008 | Production | Caribou | — | — | 1 | — |

**Table 12.2-6 Caribou Incidents and Mortality at the Ekati, Diavik, and Snap Lake Mines, 1996 to 2013**

| Site | Year | Phase | Species | Mortalities | | | Other Incidents[d] |
|---|---|---|---|---|---|---|---|
| | | | | Intentional[a] | Non-Intentional[b] | Found Dead[c] | |
| Ekati Mine[f] (continued) | 2009 | Production | Caribou | — | 4 | 4 | 2 |
| | 2010 | Production | Caribou | — | 1 | 6 | 1 |
| | 2011 | Production | Caribou | 1 | — | 4 | — |
| | 2012 | Production | Caribou | — | — | 2 | — |
| | 2013 | Production | Caribou | — | — | 1 | 1 |
| Snap Lake Mine[g] | 1999 to 2003 | Exploration | no incidents | — | — | — | — |
| | 2004 | Exploration | no incidents | — | — | — | — |
| | 2005 | Construction | Caribou | — | — | — | 1 |
| | 2006 | Construction | no incidents | — | — | — | — |
| | 2007 | Construction | no incidents | — | — | — | — |
| | 2008 | Production | no incidents | — | — | — | — |
| | 2009 | Production | Caribou | — | — | — | 2 |
| | 2010 | Production | no incidents | — | — | — | — |
| | 2011 | Production | Caribou | — | — | — | 1 |
| | 2012 | Production | no incidents | — | — | — | — |
| | 2013 | Production | Caribou | — | 1 | — | — |

a) Animal intentionally destroyed by mine or government personnel.
b) Accidental mine-related mortality (e.g., entanglement in fence).
c) Animal found dead, mortality cannot be linked to mine activities.
d) Each occasion where animals are deterred, relocated, or a damage report was filed. General observations and mortalities are not included. The number of different individuals involved may be unknown.
e) Sources: DDMI (1998, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013); Golder (2014a).
f) Sources: BHP Billiton (2001, 2002, 2003, 2004); Rescan (2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012) ERM Rescan (2013a, 2014b).
g) Sources: De Beers (2002, 2004, 2013); Golder (2006, 2007, 2008a, 2010, 2012, 2013, 2014b).
— = no mortality or incident.

#### *12.2.2.5 Other Barren-Ground Caribou Incidents*

From 1996 to 2013, there were 15 incidents at the Ekati and Snap Lake mines where caribou had to be deterred from using areas or had non-fatal interactions with infrastructure. For example, at the Ekati Mine site in 2005, one caribou became entangled in the support guy wires of a tower. The caribou was successfully freed after part of its antlers was cut off. One caribou was observed inside the fence that surrounds the Ekati airstrip in 2009. This caribou successfully rejoined a group of caribou that was on the other side of the fence.

On the Snap Lake Mine site in 2009, caribou had to be moved off the airstrip; deterrent activities were completed by personnel on foot, in a truck, and in a helicopter. In 2011, one caribou had to be deterred from entering a high-traffic area near the processing plant. Other incidents include deterring animals from airstrips and other mine infrastructure.

### 12.2.3 Summary of Local and Traditional Knowledge

#### *12.2.3.1 Yellowknives Dene First Nation*

The Ekati area is identified as a central and important location for the Yellowknives Dene First Nation (YKDFN) because it is where the caribou come in the late summer and early fall, which is when they are the most valuable. Sometimes caribou were encountered in the spring as they migrated back north toward the calving grounds around Bathurst Inlet. Unless desperate for meat, the YKDFN would not hunt the caribou during their spring migrations because the furs and hides are not very strong. If a caribou was needed, they would try to take only an older caribou or a yearling that was not ready to calve (Weledeh Yellowknives Dene 1997).

In the *Traditional Knowledge Study of Ek'ati* (Weledeh Yellowknives Dene 1997), the YKDFN repeat the Elder's insistence that caribou are the most important animal to the Dene; that they cannot survive without caribou. Traditionally, caribou have provided the Dene people with food, shelter, and clothing. Almost all parts of the caribou were used in the construction of tools and materials, such as awls, scrapers, needles, toboggans, tents, ropes, clothing, and floor mats. The fat and muscle of the caribou were eaten, prepared, and stored for travelling through the barrenlands in the winter. Even caribou teeth and gums were used for medicinal purposes to treat toothaches or other ailments (Weledeh Yellowknives Dene 1997).

For the YKDFN, the "Gras" in Lac de Gras refers to caribou fat: It can refer to a story of a hunter who survived starvation in the Ekati area by following the smell of burning caribou fat, or it can refer to the traces of floating fat left on the water's surface by swimming caribou during their fall migration. The fall caribou were an important source of fat and the thick, warm furs needed for winter survival. This vital fall hunt traditionally occurred around Lac de Gras (Weledeh Yellowknives Dene 1997).

Typically, strong males lead the fall migration, followed by cows and calves, with old males at the rear (Sadownik and Harris 1995). Before guns, the Dene people would hunt using spears, often from their canoes as the animals crossed between islands and lakeshores. One such location on MacKay Lake is known to the YKDFN as “spear the water.” The YKDFN sometimes deflected caribou using stone markers and strips of hide that would flap noisily in the wind, moving caribou towards hunters ready to shoot (Weledeh Yellowknives Dene 1997). Avoiding the leaders, Dene hunters would take caribou from the middle of the herd. If too many strong leaders were killed, the Dene thought there was a chance they would not complete their full migration (Sadownik and Harris 1995). Hunters making successful kills in the fall would cache and store their excess meat along commonly used travel routes so that other groups could take advantage of the meat and fat, if necessary (Weledeh Yellowknives Dene 1997).

In the spring, the caribou begin migrating north towards the calving grounds around Bathurst Inlet. This migration can start as early as April (Sadownik and Harris 1995). By April, cows and calves can be found around MacKay Lake, Lac de Gras, and Lac du Sauvage. As they move north, they use the same trails they used the previous fall to move south. Mature bulls follow the cows and calves, arriving at the calving grounds after the calves are born. They stay there until the calves are strong enough to make the trip back south in the fall (Weledeh Yellowknives Dene 1997). The caribou migrate slowly in the spring and summer, feeding and putting on fat for the winter. Where bulls find rocks, such as those found in stands on either side of the Lac du Sauvage - Lac de Gras Narrows (Narrows), they will rub the velvet-like skin off their antlers. If found, this velvety skin could be used by people to make hats and suspenders, and could be used for decoration.

If temperatures remain warm in the late summer and fall, caribou may continue moving between Lac de Gras and MacKay Lake to avoid woodland insects, feeding and waiting for cooler weather. Weather and snow conditions influence many of the caribou travels. They avoid deep or crusty snow and windy lakes. Deep snow makes walking and foraging more difficult for the caribou. Leaders have to break trails for the herd, and caribou have to dig deep to find lichens. In spring and fall, the caribou prefer soft snow conditions (Sadownik and Harris 1995).

The YKDFN identified the Narrows, and the Lac du Sauvage esker as critical caribou migration routes. They expect caribou use of the Narrows to increase as the animals attempt to avoid active mining operations. They have recommended the filling of dangerous gaps in rocks at these crossings in an attempt to avoid serious injury to migrating caribou, especially calves. There is concern that reduced time spent in the calving grounds as a result of increasing development activity and habitat disturbance puts the very young animals at risk. The YKDFN Elders have strongly recommended that all of the caribou calving grounds become protected areas, and that the Lac du Sauvage esker and the Narrows remain in place, undisturbed, for caribou use and deflection from the active mine site. Despite the presence of the esker and Narrows, the YKDFN warn that caribou and other migrating animals will likely continue to use the shoreline near the esker (Weledeh Yellowknives Dene 1997).

Until the 1940s, the Bathurst caribou followed the same migration route from the calving grounds to Contwoyto Lake, then east and west around Contwoyto Lake. Between Contwoyto Lake and Lac de Gras, the caribou split to winter in three different areas below the treeline: in the Tłįchǫ territory to the west, east of Great Slave Lake, and south of Great Slave Lake. Since the onset of development in the north around 1940, the caribou no longer migrate through much of the north or east arms of Great Slave Lake, preferring to stay to the west or east of the lake (Weledeh Yellowknives Dene 1997).

In an effort to deter caribou from entering the mine-site camps, the YKDFN suggested that camps should be located amongst boulders.

### *12.2.3.2 Łutselk'e Dene First Nation*

The Łutselk'e Dene First Nation (LKDFN) rely heavily on the caribou. The caribou are highly respected because they are what the Dene most depend on for survival while on the land. In an effort to monitor the health of the caribou, hunters make observations regarding the health of harvested caribou using such factors as location and thickness of fat deposits, colour and consistency of bone marrow, and/or developmental stage of a fetus in relation to the time of year (Shaw n.d.).There are also rules surrounding the treatment of caribou once harvested. For example, pregnant, fertile women and children should avoid certain parts of the caribou, and only the Elders should eat particular pieces of a caribou. If these rules are broken, bad luck or sickness may result (Parlee and Marlow 1997).

Hunters follow the caribou, hunting and trapping to provide for their families and community (Parlee and Marlow 1997). With additional developments on the land, the people of Lutsel K'e have expressed concerns about the caribous' own ability to travel. During site visits, Elders have identified potential barriers and hazards to caribou movement, including high ridges and sharp rocks along the edges of the roads (BHP Billiton 2011). Participants in the 2011 Wildlife Effects Monitoring Program suggested that the Ekati Mine should install fencing around all the open pits to protect caribou and other wildlife, but also noted that all caribou observed around the site appeared to be in good health. They also identified a "yagoose," a strong, powerful bull with large, sharp antlers, a large head, and a thick, dark coat, among the herd (BHP Billiton 2011).

> *The caribou are good here, healthy, strong, good coats. If the caribou are not healthy you could tell, you could see their ribs, the way the coat is and the way they walk*
> (BHP Billiton 2011).

Despite the apparent good health of the caribou, members of the LKDFN are concerned about the declining caribou numbers and their shifting migration patterns, with caribou remaining longer now in the barrenlands and coming into Lutsel K'e less and less. They have also expressed concern about the number of bulls hunted by outfitters: "There are not enough bulls, that's why we have dry cows" (BHP Billiton 2011).

### *12.2.3.3 Deninu Kué First Nation*

Seasonal movements of the Deninu Kué First Nation (DKFN) were not random. The Deninu K'ue Ethno-History Report (DKFN 2012) explains that the Dene moved through the landscape along the caribou herds' migratory ranges. The fall caribou hunt provided an important source of fat, food, and thick, warm furs needed for the upcoming winter. The best caribou skins were from caribou hunted from August to October when the hides were the thickest and the hairs firmly attached. Approximately 13 to 15 caribou skins were required to properly clothe and shelter each adult for the winter (Hearne 1795). In the spring, caribou were hunted on the tundra as they returned to their summer habitat in the barrenlands. Today, moose and caribou are consumed almost equally, while bison, whitefish, pike, inconnu, ptarmigan, and goose supplement the traditional summer diet (Dezé 2009).

The Bathurst caribou herd is the herd most often exploited by the DKFN traditionally. The traditional seasonal patterns of the Dene depended largely on the movements of the caribou. A harvested caribou provides meat, furs, skins, sinew, bones, and antlers. Caribou hide was used for tents, clothing, snowshoes, sledges, snares, and babiche. Caribou bones and antlers were carved into tools, and the caribou meat was used for food. When the trading posts became established, caribou hide was not a sought-after commodity, but caribou meat was an important source of provision. All the meat was (and still is) taken home to share with other members of the family and the community. Caribou meat is often kept frozen in the winter, and dried and smoked in the summer, to keep it preserved (DKFN 2012).

The caribou hunt is an important event for the entire family. Older generations pass their knowledge on to the children so that they can one day support themselves. Local knowledge of the caribou and its behaviour can be very detailed. Dragon (2002), for example, has noted discrete changes in caribou temperaments/approachability based on season, temperature, and herd characteristics.

Caribou skins continue to be used by members of the DKFN. The DKFN "[u]sed to wear caribou skin gloves; everyone used to get gifts: gloves, moccasins, blankets, etcetera of caribou skin"; "jackets, shoes, [and] clothing"; "[s]hoes, mitts, vests, slippers, hats, [and] jackets. Everything you could use the hides for. Dresses. A lot of people got married in caribou hide dresses"; "nobody threw the hides away. Nobody got shoes in the store" (DKFN 2012).

A special delicacy when preparing freshly harvested caribou was the boiled caribou stomach, its contents, and blood. The stomach would later be hung and smoked for several days (Hearne 1795). Dried meat was also an important source of food while travelling. In the summer, caribou were often hunted from canoes using long sticks and spears (DKFN 2012). The DKFN were told by their ancestors to hunt with care and regard for the future of the caribou.

Elders say that when caribou pass a camp on their way south from the summer grounds, people should let them pass for a day before beginning the hunt. They believe that by letting the leaders pass by and hunting from the middle of the herd, the migration of the herd will not be disturbed. If the lead caribou are killed, the herd may change its migration route (GNWT n.d. in DKFN 2012). “If we killed all our leaders we would be confused too” (DKFN 2012).

The DKFN have expressed concerns about the mines and the ease of access now provided by winter roads. They believe that the mines, increased traffic, noise, and hunting have all affected the caribou migration (DKFN 2012):

> *In 1996 it was the year I saw the most caribou around Caddy [Ekati] mine. The environmental people said it was a herd of about 10,000. It came through one evening and the hills in front of the camp were just full of caribou. It looked like the hills were moving. That was the only year I've ever seen caribou like that at the Caddy [Ekati] diamond mine. A few years after the mine started the caribou stopped coming through there. They found somewhere else, they go somewhere else… they're built right on the migratory route. That's what I gathered when I saw them on the BHP property* (DKFN 2012).

This important food source for caribou, according to DKFN members, is being affected by the development of the mines and the winter roads causing them to change their migration patterns:

> *The lichen has been burnt (takes 100 years or so to grow back) in the 1980s forest fire by Rocher River. That's why the caribou don't come back to Rocher River no more but they used to* (DKFN 2012).

> *Before the mines they used to move around everywhere. It takes the lichen a long time to grow. But now the chemicals from the mine are infecting their food* (DKFN 2012).

### *12.2.3.4 Fort Resolution Métis*

In general, the caribou migration follows a south-southwesterly direction in the fall out of the barrenlands, and a north-northeasterly direction in the spring. These migrations have typically crossed through Aylmer Lake and the surrounding area where their trails can be seen embedded in the landscape (NWTMN 2012).

Caribou were regularly found in plenty around Gordon Lake and MacKay Lake, but have been found less commonly in these areas over the past few years. The Fort Resolution Métis acknowledge the natural movement of the caribou through time, but stress the significance of maintaining sufficient suitable habitat to support healthy populations and the successful adjustment of the herds as they move. A healthy caribou herd will continue to provide healthy foods for the Métis people. The presence of the mines and access roads have been identified as potential stressors for the caribou and, as a result of recent evidence suggesting some caribou are overwintering on the barrenlands, may present a danger or barrier to the animals while winter traffic is active (NWTMN 2012).

### *12.2.3.5 North Slave Métis Alliance*

Caribou is an important part of the Métis culture and diet. Many Métis have complained about their growing dependence on store-bought meat, and the health and cultural implications of having to change their diet. The Métis are concerned about the impacts that mining developments are having on the caribou herds, their health, and their migration patterns. The Métis have expressed their concerns about caribou mortalities in the vicinity of the Ekati Mine (IEMA 2011), and they are concerned that they may no longer be able to access the caribou as they once did.

Métis knowledge of the entire caribou migration area and caribou behaviour as they travel provides insight into on the caribou use of lands from Great Slave Lake to Bathurst Inlet:

> *It's a big migration of caribou that goes through. They start from near Bathurst Inlet around the last week of July. About the 25th of July to the first of August, they will hit Pellatt Lake and go along Contwoyto Lake. Then they go around and head northwest of Fort Rae, maybe a hundred miles* (BHP 1995).

Members of the North Slave Métis Alliance (NSMA) have identified the islands of Lac de Gras as important resting and grazing areas for the migrating caribou, they recall hunting in the area of Contwoyto Lake, and have discussed the importance of Lac de Gras to the caribou migration:

> *It is right in the middle of their migration route. When they are travelling south and heading back home to their calving grounds in the spring, the Lac de Gras area is right dead centre* (NSMA 1999).

Others suggest that Lac de Gras is an unreliable area for depending on caribou and that developments in the area will not seriously impact the migration:

> *Lac de Gras is kind of a bad place because sometimes you get caribou and sometimes you don't. There were trappers that lived there long ago, maybe 50 or 60 years ago. White trappers went out there and just about starved because the caribou didn't come. They changed their migration. The mine is not going to affect them* (BHP 1995).

> *If it [the mine] is on their migration route, they [caribou] would probably just pass through camp* (BHP 1995).

Whenever it is available, caribou is shared between friends and families; children were raised on fish and caribou, and the very act of sharing the meat promoted cultural well-being and solidarity for the NSMA. All parts of the caribou were used:

> *Make jacket. Make moccasins. Moose hide. Make moccasins from it, but top we put caribou hide. Yeah. And we make a vest. The old timer, when you go trapping. My Mom, I remember make a vest with caribou hide, not to get cold. Everything, they make (?) out of moose hide and then dog harness with caribou hide. They make babiche with caribou hide. All kinds of things they made sleigh, snowshoe. ...And when caribou meat's good they make dry meat, make everything, they make stew meat. All the things they make with one caribou. They don't throw nothing away. Everything, the bones, the feet, the bones that were from the feet, big cords. They [put] that in the tepee tent. They dry that with little bit smoke, smoke `em. And after they put away. Summertime, when they want some soup they boil, they boil, they boil, it get really soft...* (NSMA 1999).

Not only would the diet and health of the NSMA change if caribou are negatively impacted, so too would social relationships of the Métis themselves. Caribou are an important source of sustenance, and a catalyst for social interaction between friends and between generations.

The NSMA have seen how the gold mining activities in the Yellowknife area have affected the caribou migrations. Old Fort Rae on the North Arm of Great Slave Lake was established largely because of the reliable availability of caribou. Today, the caribou no longer migrate through the area. Forest fires also impact the habitat of the caribou, changing their travel route. The NSMA fear that the cumulative effects of the diamond mines and other disturbances will further impact the caribou migrations, the health of the herd, and population. In addition to disturbances to the migration patterns, the NSMA have expressed concern about the direct impacts of dust, the presence of the large open pits, increased traffic, and improved hunting access.

The NSMA believe that the presence of the diamond mines will push the caribou migration east, making it more difficult for people to hunt:

> *All these mines will affect our caribou. Maybe they're [caribou] gonna go east someday instead of towards our community anymore. They're probably gonna do that.... Yeah, they're probably gonna go this way [east] pretty soon if these mines get put up. People wouldn't like that because we won't see no caribou in our area anymore. Every one of them will be on the east side, and we're gonna go a long way to hunt caribou for sure* (NSMA 1999).

Others thought it might split the migration around the mines towards Great Bear Lake in the west and Lutsel K'e or Saskatchewan in the east.

Wolves have been and continue to be trapped for their furs by the NSMA. The wolves follow the caribou, "they kill the weaklings" (BHP 1995), and so they are found in the Ekati area around the same time as the caribou, moving from lake to lake. The wolf-caribou relationship is one of interdependence. The NSMA have expressed thoughts about the intelligence of the wolves, and their importance to the health of the caribou:

> *Foxes do more damage to a caribou than a wolf does because a fox doesn't know its calving season. The little guy comes out, hits the ground, the fox is not big enough to kill it so he winds up biting holes in it and then it gets sick and then the wolf comes and cleans up. So that's why I don't like shooting wolves because I know that if the wolf is gone, then the caribou will be sick* (NSMA 1999).

The NSMA have expressed concerns about the impacts of dust on the caribou food in the area of the mines, such as moss, lichen, and muskeg:

> *...Dust will affect their [caribou's] food. To what extent, I don't know what studies have said, what kind of studies have been done. ...Lichens and muskeg they usually pick up a lot of pollution anyway, not a lot of pollution, but they are a sort of sponge. They pick up some contaminants, but not all. I don't know how the dust would affect the lichen* (NSMA 1999).

### 12.2.3.6 Tłįchǫ Government

The relationship between the Tłįchǫ and the caribou is based on mutual respect. The Tłįchǫ identify the caribou as individuals with the power to make decisions based on their relationships with humans. Disrespectful behaviours will keep the caribou away from the people, while the respectful treatment of caribou and their remains will bring the caribou to the people and facilitate the rebirth of the caribou spirit maintaining the health of the herds (Jacobsen 2011). To show respect, all parts of a harvested caribou are used: the meat and bones for food, and the skins for clothing (DCI 1995). The fall caribou provided the best skins for the production of clothing (Sadownik and Harris 1995).

The Tłįchǫ Elders say that the caribou follow the cold weather and the wind, and the changes in the climate and the wind are changing the timing and character of caribou migrations. The Tłįchǫ have noticed that the caribou are waiting longer in the barrenlands, that their migration south through Tłįchǫ territory has been pushed from October or November to around December, that they are moving back onto the tundra earlier in the spring, and that the caribou are more dispersed now than they ever used to be (Jacobsen 2011).

The Ekati area, specifically the Narrows between *Ek'ati* (Lac de Gras) and *Nòdixati* (Lac du Sauvage) have been identified by the Tłįchǫ as an important part of their traditional hunting area. Tłįchǫ people lived in this area to hunt the caribou as they migrated through the Narrows. "*They are easy to hunt at this spot*" (DCI 1995).

Tłįchǫ Elders have noted that the warmer, drier climate that has characterized the last few decades has resulted in more frequent forest fires in the summers. They have also recognized changes in the amount, depth, and consistency of the snow and ice, with deeper, softer snows in the winter, and thinner, crusty ice. The large fires burn the caribou feeding grounds, the deep snows bury the lichen, and the thin, crusty ice pose dangers to the caribou crossing lakes. These altered conditions have made travel more difficult for the caribou. Elders note that these are reasons why the caribou are skinnier than they once were (Jacobsen 2011).

Tłįchǫ people have also expressed their concerns about the mine's impacts on caribou and other wildlife. They fear that presence of a mine might further limit the movement of the caribou by affecting the migration route and patterns:

> *There are [also] a lot of wolves and fox dens where the mine is [proposed on Ek'ati]. And the caribou migrates there too. It's like they're blocking its [caribou] path. A lot of people don't like that; they don't like it at all* (DCI 1995).

Concerns about mine infrastructure, roads, and fencing have also been expressed. The Tłįchǫ want to determine that these features are not inhibiting the movement of caribou through the Ekati Mine site. Elders have warned that wildlife monitors at the Ekati Mine should monitor site fences to make sure caribou do not get stuck if they try rubbing the fur from their antlers using mine infrastructure, such as the fences around the airstrip or open pits (IEMA 2011).

Tłįchǫ Elders state that caribou use their sense of smell to locate the best vegetation (WKSS 2001a,b). As such, they have concerns about the smell of oil and gas from developments overpowering the smell of food that would normally guide caribou to the best range (WKSS 2001a,b). Recent burns may also be avoided by caribou because they cannot smell food, just burnt vegetation (WKSS 2001a).

Tłı̨chǫ Elders have noticed that because of the warmer, drier climate, the lichens (*adzii*) that the caribou feed on have become dry and now die before the caribou get to feed on them (Jacobsen 2011). Lichen is the primary food source for caribou, and just like people like different types of food, caribou like to eat various types of lichen (Dominion Diamond 2013).

#### *12.2.3.7 Kitikmeot Inuit Association*

Inuit hunted caribou and fished in the fall while preparing themselves for the winter trapping season. They travelled mostly on foot, backpacking supplies with their dogs. The caribou had nice, thick fur in the fall and this was the best time to harvest them for clothing, blankets, kayaks, and tents. The caribou meat that was not eaten right away would be dried or cached for the winter. A few bull caribou would be taken for their fat reserves, which would be used in *kudlik* (stone stoves). The guts of the caribou were buried in the fall and used as bait where traps would be set for the wolves, wolverine, and foxes before the winter trapping season (Banci et al. 2006).

During summer, Inuit from around *Tahikyoak* (Contwoyto Lake) established camps and hunted all over, looking for any type of wildlife they could catch for food. The distribution of caribou was the most uncertain in the summer, and the Inuit would usually spread out into smaller groups. The locations of the summer camps would change every year depending on where the wildlife were, but often centred around narrows where caribou were most likely to cross. Cows would begin to head south as early as July, with the bulls following around the end of August.

During a tour of the Ekati Mine about traditional knowledge and wildlife monitoring, Vivian Banci (Banci et al. 2006) recalls the advice of two Elders from Kugluktuk who told her that the "*by understanding where the caribou traveled, we also understood where and why people traveled, hunted and lived. The caribou were central to the carnivores, the wolves, wolverines, bears and foxes. Their preferred habitats were the preferred habitats of avingak, hikhik and okalik. Only by walking in the path of the caribou could we hope to understand the complex ecology of this beautiful land.*"

Inuit show a respect to the caribou they depend on for their survival. When preparing and butchering the animals all work areas were kept clean. Caribou were never hunted on the calving grounds or butchered along the traditional migration paths, including the *nadlok* (narrows) at Ekati. When possible, caribou from the middle of the pack were targeted so that the strong leaders remained with the herd. Bulls were hunted only when needed for their fat and warm skins.

*Inuksuit* (stone markers) were constructed to herd caribou and to mark cache locations. These markers are most effective in the spring and fall for herding caribou, but may not work in the summer when it is hot or if caribou are travelling in large herds (Banci et al. 2007). In the winter, Inuksuit would be built high so that hunters travelling the lands could see where meat was stored beneath the snow (Banci et al. 2006). Sometimes, Inuit hunters disguised themselves as other animals to trick the caribou and get close to the herd (Sadownik and Harris 1995).

> *Caribou meat was a preferred food for all Inuit and caribou skins were preferred for clothing. Seal skins were more waterproof, for kayak and summer tents. Because of differences in timing of the availability of wildlife, however, Inuit could not concentrate on both caribou and seals and relied on trading to obtain what they lacked. Inlanders traded their caribou and fox skins for seal skins and other marine mammal products provided by coastal people* (Banci et al. 2006).

In 1961, a Royal Canadian Mounted Police report stated that Kitikmeot Inuit Association (KIA) living inland supplied as much as 95% of the clothing skins for Inuit on the Arctic coast from Coppermine, Bathurst Inlet, Read Island, and Holman on Victoria Island (Banci et al. 2006). The Inuit worked hard to preserve the meat, skinning and butchering the animals immediately. Caribou skins were used to make pants, underwear, footwear, mitts, and parkas. Pelts from caribou calves were said to make the best clothing because of their softness and pliability. Pelts were used as bedding, placed on top of muskox, grizzly, or polar bear skins, or willow branches, to keep them dry. Skins from yearlings were used for the inside lining of parkas, and for pants and parkas. On hunting trips, skins from freshly killed caribou were used as blankets and sleeping mats, so that these did not need to be packed. Dried caribou skins were formed into balls for games, and drums were made from caribou skin stretched over a wood frame (Banci et al. 2006).

Nothing was wasted. Any excess meat was dried or buried in clay to be used later for food or bait. The *nigokak* (stomach, its contents and intestines) were mixed with fat and eaten, the marrow was extracted, and the belly of the caribou was sometimes used to make packs for the dogs to carry food and supplies. Caribou back and leg sinews were used as thread, and bones were used as sewing needles. Braided caribou sinew was used as decoration on bows, and as snare wire to catch ducks in their nests. Caribou bones and antlers were made into a variety of tools and implements, or could be used to fuel a fire. Shoulder blades were used as scrapers, and carved and used as fly swatters; ribs were used as drills; large leg bones were used as ice chisels; caribou antlers were shaped into bows, snow knives, ulu handles, fishhooks, and spears (Banci et al. 2006).

Lac de Gras was known to be a good spring hunting area. Travelling this far was easier once the Inuit acquired snow machines. There were a lot of caribou at Lac de Gras, crossing the narrows and bedding down on the islands. Caribou could always be found on the islands, especially in the summer, at Lac de Gras, Contwoyto Lake, and Pellatt Lake (Banci et al. 2006). From the water, caribou could be hunted using the long thin kayaks, characteristic of the Inuit, made from a willow frame covered in caribou or seal skin. On land, hunters waited behind *talo* (hunting blinds), constructed Inuksuit (stone markers) to herd the caribou towards waiting hunters, or chased the caribou on dogsled. Before acquiring guns, hunters would use bows and arrows and spears to catch the caribou (Banci et al. 2006).

Inuit take the time to watch the caribou before hunting, identifying the healthy from the unhealthy by observing the profile of the backsides of the animals and the way it is walking (BHP Billiton 2011). In the spring, young bulls can be identified from the females by observing hair loss between their neck and shoulders from rutting activities. For caribou with horns, the males can be distinguished from the females in the spring by looking for the velvet coating. Female caribou have small horns in the spring with no velvet to protect their calves, but they drop these horns near the end of August (BHP Billiton 2011).

The KIA have expressed concerns about the impact of the Ekati Mine on caribou and other animals in the area:

> *The landscape wouldn't be the same. It might cause confusion for the wildlife* (BHP 1995).
>
> *I'm sure it will probably make them [caribou] change direction. They may change their migration pattern. It might have psychological effects, they won't be able to mate and have as many… young caribou, it might affect their numbers in time* (BHP 1995).

DOMINION DIAMOND

> *Sometime caribou… [follow] a road instead of crossing it… and that's when migrations routes… change* (BHP 1995).

Members of the KIA have concerns with how the development might impact the availability of caribou in the future for their children and grandchildren, and have recommended that if the development proceeds that it limit its footprint as much as possible:

> *If they start working on the site and the animals go elsewhere, it won't [be] alright* (BHP 1995).

> *We can't afford to live exclusively off food we get from the store. We have to supplement it with caribou… A lot of people in the community sustain themselves almost exclusively on caribou meat* (BHP 1995).

Others did not think the development of the Ekati Mine would have serious impacts:

> *I don't think it's gonna have that much effect on the wildlife… look at Echo Bay, there's caribou [and] musk-ox walking right around the buildings they're not worried, nobody's chasing them…, it's just like a National Park, the animals are protected and nobody's harassing them* (BHP 1995).

In response to concerns about the Ekati Mine, KIA participants have provided feedback to Ekati staff to help minimize the Project's impacts on caribou and other wildlife. In 2006, the Kugluktuk Elders Advisory Group recommended that more Inuksuit be built and made more visible by adding flagging tape, by making them larger, or by painting 'hats' on them. They also suggested that Inuksuit be rebuilt and moved each year. They discussed creating wolf and Inuksuit silhouettes out of wood to help deter caribou from entering certain areas of the mine, and recommended that such deterrents remain until after mine closure. They further recommended that BHP erect a fence to deflect and protect caribou from mining at the Beartooth Pit (Banci et al. 2007). With the success of this fence, in 2010, the airport electrical fence was removed and replaced with the same type of fencing as at Beartooth. New fences were also installed to deflect animals at the Pigeon Pit and Misery Camps (Rescan 2011). In 2011, Inuit participants in the Wildlife Effects Monitoring Plan suggested that caribou crossings at the roads should be larger to facilitate caribou movement, especially if in the presence of predators.

In addition to the impacts from increased development, Inuit who have participated in the Caribou and Roads Workshops have identified improved methods of access and a changing climate as additional factors putting pressure on the caribou. The increased occurrence of freezing rain in the winter, for example, makes it more difficult for caribou to forage through the snow, and can result in poor calving success. From 1950 to 1955, Inuit noticed a decline in the herds as a result of freezing rain conditions (Banci et al. 2007).

Wolves are a main predator of the caribou and can sometimes be responsible for declining caribou populations (Banci et al. 2007). As of 2007, KIA participants in the Caribou and Roads workshops recognized that the wolf population around the Ekati Mine was beginning to decline. They note that wolf and caribou have been living together for thousands of years, and that wolves will decline as the caribou do (Banci et al. 2007).

# 12.3 Pathway Analysis

## 12.3.1 Methods

Pathway analysis identifies and assesses the linkages between Project components or activities, and the correspondent changes to the environment and potential residual effects (after mitigation) to VCs.

The first part of the analysis is to identify all potential effects pathways for the Project. Each pathway was initially considered to have a linkage to potential effects on barren-ground caribou. Potential pathways through which the Project could affect barren-ground caribou were identified from the following sources:

- a review of the Project Description, and scoping of potential effects by the environmental and engineering teams for the Project;
- local and traditional knowledge obtained from community scoping sessions in Behchokǫ̀, Yellowknife, and Łutselk'e, and a technical scoping session in Yellowknife (Section 4);
- information from past and ongoing consultations with Aboriginal communities that are part of the Ekati Mine Community Engagement Programs;
- scientific knowledge and experience with other mines in the NWT; and,
- consideration of potential effects identified from the Terms of Reference.

Construction, operation, and closure of the Project will cause several changes to the existing environment that will result in potential effects on barren-ground caribou. The Project components and associated activities that could potentially affect barren-ground caribou include the following:

- roads, pipelines, and power lines to Lac du Sauvage;
- increased traffic on the Misery Road;
- quarrying of granite rock for construction material and/or use of granite rock mined from the Lynx Pit;
- continued use of the TCWR due to the Project and continued opportunities for harvesting of caribou;
- exposure of caribou to dewatered lakebed;
- diversion of a small drainage area on the northwest shore of Lac du Sauvage (Sub-basin B Diversion Channel) to direct the Christine Lake outflow south around the dike into the main basin of Lac du Sauvage;
- Lac du Sauvage pumping stations for initial dewatering and ongoing operational pumping;
- open-pit mining of the Jay Pit;
- Jay waste rock storage area;
- processed kimberlite deposition;
- dust deposition on vegetation;
- continued use of the Ekati main camp, processing plant, airstrip, and all other related facilities;

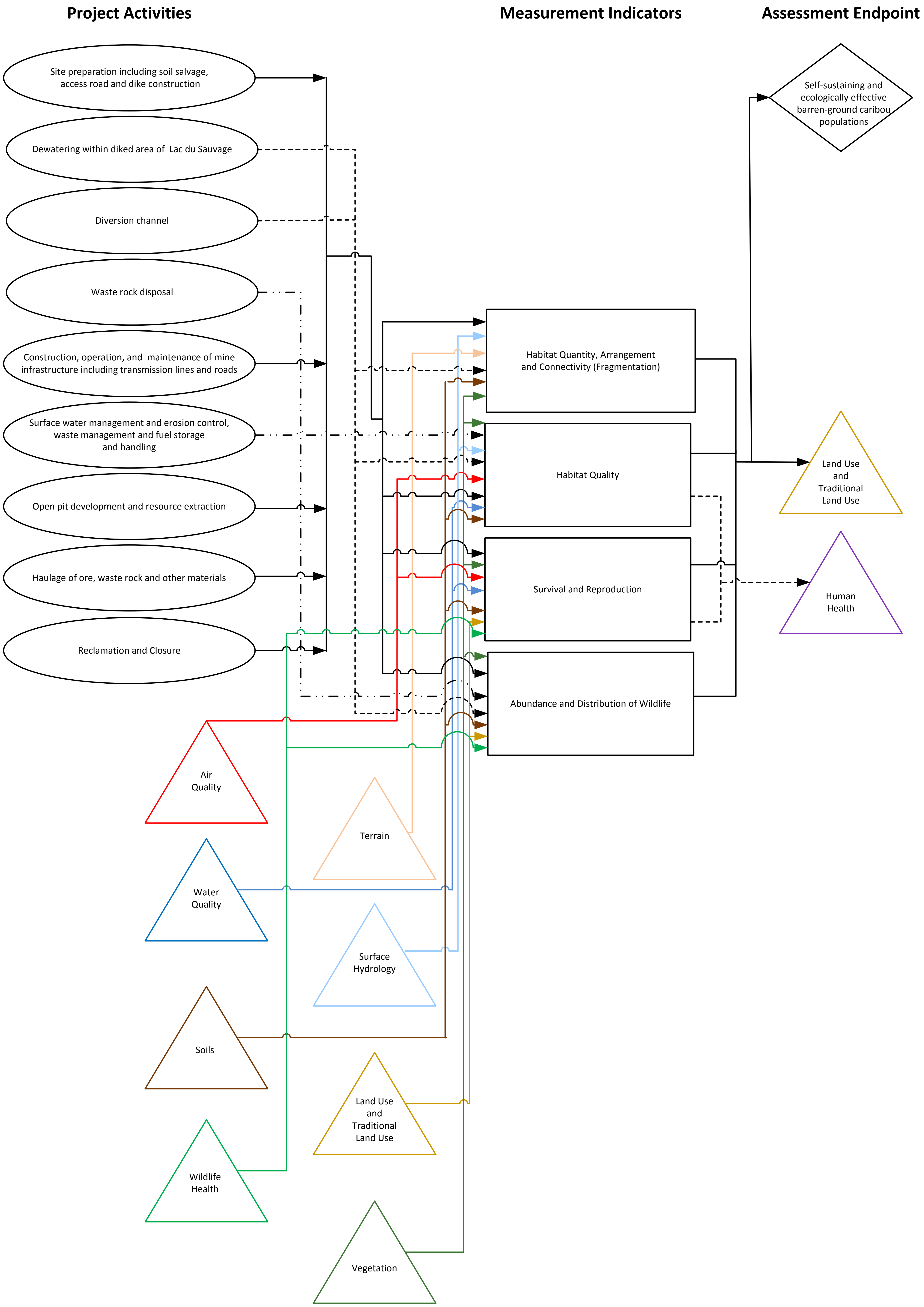
- fuel and material management;
- reclamation of the Jay Project (re-established surface flows, dike breaching, and other activities); and,
- ongoing reclamation of completed areas (certain areas of the LLCF, and others).

These Project-environment interactions (or linkages) can generate multiple effects on barren-ground caribou. For an effect to occur there has to be a source (Project component or activity) that results in a measurable change to the environment (pathway or measurement indicator) and a correspondent effect on this VC.

**Project Activity** → **Change in Environment** → **Effect on VC**

Project components and activities that are linked to changes in measurement indicators are illustrated as ovals in Figure 12.3-1. Effects from the Project on other disciplines that can influence measurement indicators for caribou are shown as triangles on the left side of the figure (e.g., air quality, hydrology, water quality, vegetation). Similarly, changes to caribou can affect other disciplines such as land use and traditional land use (shown as triangles on the right side of Figure 12.3-1). Ultimately, changes in measurement indicators can have an effect on the assessment endpoint for caribou (represented by the diamond).

**Figure 12.3-1: Linkage Diagram Identifying Potential Effects on Barren-Ground Caribou**




Note: Ovals represent Project activities, rectangles represent measurement indicators, triangles represent connections to and from other disciplines, and the diamond represents the assessment endpoint.

A key aspect of the pathway analysis is to identify environmental design features and mitigation that might reduce or eliminate potential effects of the Project to barren-ground caribou, and includes application of the precautionary principle (Section 6.1.2). Environmental design features include engineering design elements, environmental best practices, management policies and procedures, and spill response and emergency contingency plans. Environmental design features and mitigation were developed as an integral part of the Project's design through an iterative process between the Project's engineering and environmental teams to avoid or mitigate adverse effects identified by the pathways analysis.

After applying environmental design features and mitigation, a screening-level analysis is used to determine the existence and magnitude of linkages from the initial list of potential effects pathways for the Project. This screening step is largely a qualitative assessment and is intended to focus the effects analysis on pathways that require a more comprehensive assessment of effects on barren-ground caribou. Pathways are determined to be primary, secondary (minor), or as having no linkage, using scientific, local, and traditional knowledge, logic, and experience with similar developments and environmental design features and mitigation. Each potential pathway is assessed and described as follows:

- **No Linkage –** analysis of the potential pathway reveals that there is no linkage, or the pathway is removed by environmental design features or mitigation such that the Project would not be expected to result in a measurable environmental change and would therefore have no residual effect on barren-ground caribou relative to the Base Case; or,
- **Secondary –** pathway could result in a measurable minor environmental change, but would have a negligible residual effect on barren-ground caribou relative to the Base Case, and is not expected to contribute to effects of other existing, approved, or reasonably foreseeable projects to cause a significant effect; or,
- **Primary –** pathway is likely to result in environmental change that could contribute to residual effects on barren-ground caribou relative to the Base Case.

Pathways with no linkage to barren-ground caribou are not assessed further because environmental design features or mitigation will remove the pathway. Pathways that are assessed to be secondary and demonstrated to have a negligible residual effect on barren-ground caribou through simple qualitative or semi-quantitative evaluation of the pathway are also not advanced for further assessment. In summary, pathways determined to have no linkage to barren-ground caribou or those that are considered secondary are not expected to result in environmentally significant effects on self-sustaining and ecologically effective barren-ground caribou populations. Primary pathways require further evaluation through more detailed quantitative and qualitative effects analysis (Section 12.4).

## 12.3.2 Results

### *12.3.2.1 Review of Mitigation Effectiveness*

#### *12.3.2.1.1 Non-Vehicle Wildlife Incidents and Mortalities*

Employees at the Ekati Mine have found that the effectiveness of wildlife mitigation efforts to reduce wildlife conflicts with the mine can vary. For example, the chain-link fence around the Misery camp that was designed to reduce the presence of wildlife in the camp area is only effective if the gates are kept closed and if the fence is maintained in good repair. Once an animal gains entrance, the chain-link fence makes removal more difficult.

#### *12.3.2.1.2 Vehicle or Aircraft Collisions*

**Airstrip Deterrents**

Several mitigation efforts have been implemented over the years to limit caribou access to the Ekati airstrip. The airstrip was initially surrounded by a four-strand electric fence. However, in 2001 and 2002, caribou gained access to the Ekati airstrip on several occasions by breaking through the electric fence or using open gates. To try to prevent caribou from breaking through the fence, the number of stands of electrical wiring surrounding the airstrip was increased from four to eight strands (BHP 2003). However, from 2002 to 2004, three caribou were killed as a result of being caught in the wire strands of the electric fence.

Elders and community members suggested the construction of a rope fence and the addition of flagging tape to the fence to prevent more caribou deaths. These deterrents were implemented in 2003 and 2004. In 2009, one caribou was killed after becoming entangled in the rope fence, and three caribou were killed after becoming entangled in the electric fence. In response to these deaths, BHP immediately removed the remainder of the rope fence, painted the tops of the fence posts a bright colour to provide greater contrast, installed a test section of orange barrier fencing, and initiated a comprehensive fence surveillance program (Rescan 2010).

Another caribou was killed by entanglement in the electric fence in 2010. In response, an orange barrier fence was erected to replace the electrical fencing. Caribou have been observed jumping this orange barrier fence and in 2011, one caribou was euthanized after many attempts to deter the individual from the airstrip. Plans are being developed to heighten the barrier above a caribou’s line of sight to prevent caribou from jumping over it in the future (ERM Rescan 2013a). Monitoring indicates that wildlife are able to get past the orange barrier fencing, and the effort required for annual maintenance and ongoing airstrip inspection/clearing is high.

**Road Closures**

Road closures have been identified as an effective method for reducing vehicle-caribou interactions. However, road closures also interrupt sensitive operational processes. Feedback from monitoring indicates that improving the ability to predict and detect caribou around the site would be helpful for advanced planning of road closures.

#### Vehicle Collisions on Mine Roads

Mitigation efforts to limit vehicle-caribou collisions, such as speed limits and radio communication of wildlife presence, appear to be successful. No caribou have been killed on mine sites through vehicle collisions in the NWT since 1996 (Section 12.2.2.4). Radio communications about the presence of wildlife are an effective mitigation for limiting wildlife-vehicle collisions. The placement of wildlife crossing signs is re-assessed when necessary, when habitat around the mine changes due to operational or reclamation activities, or as new information about habitat use becomes available. The Ekati Mine provides employee training about the wildlife right-of-way policy, including how the Environment Department responds to the calls.

#### Vehicle Collisions on the Tibbitt to Contwoyto Winter Road and Winter Access Roads

Mitigation implemented for commercial traffic on the TCWR includes speed limits, communication between drivers of caribou presence, and regular security patrols. Drivers observing wildlife incidents are encouraged to contact ENR directly.

Mitigation on the winter road appears to be effective. Although traffic volumes on the winter road range from 3,506 to 10,922 trucks per operating period, 7 caribou mortalities have been reported along the TCWR from 1996 to early winter 2014 (Near 2014). Five animals were killed in 1999, and two caribou were struck by a vehicle in January 2014 near the Lockhart Lake Winter Road Camp. One animal was killed on impact and the other sustained injuries. On February 1, 2014, a pick-up truck on the Gahcho Kué Project winter access road stopped after noticing a group of approximately 50 caribou. Approximately 20 of these caribou then ran towards the truck. At least 2 caribou struck the vehicle resulting in 2 mortalities (De Beers 2014).

### *12.3.2.1.3 Waste Management*

Implementation of waste management and wildlife mitigation plans have been effective at limiting the risks of injury and death to caribou at diamond mines in the NWT. No caribou have been killed because of waste management issues at mines in the NWT since 1996 (i.e., before the Ekati Mine was started). The Ekati Mine operates under a Waste Management Plan approved by the Wek'èezhìi Land and Water Board, which describes objectives, practices, and monitoring. The Ekati Mine Waste Management Plan, including enhancements that may be made from time to time, will apply to the Jay Project. Training and awareness on the waste management practices is provided to Ekati Mine employees.

#### 12.3.2.1.4 Open Pits

The presence of open pits may lead to wildlife injuries or deaths through the presence of steep cliffs, blasted rock, and traffic. No caribou mortalities from animals entering the open pits at mines in the NWT have been reported (ERM Rescan 2014b; Golder 2014a,b). Caribou mitigation in the vicinity of open pits has included the installation of ‘snow’ fence in the Beartooth and Pigeon areas. At Beartooth, a single line of fencing was installed in 2006 on the northeast side to deflect caribou around the immediate area, which demonstrated that fencing of this nature can have a positive effect. At Pigeon, fencing was placed around the test pit after its completion in 2011. No caribou were seen inside the Pigeon fence. This is the same general approach to fencing that was also installed around the airstrip in place of a previous electric and rope strand fence.

### 12.3.2.2 Pathway Screening

Project components and activities, effects pathways, and environmental design features and mitigation are summarized in Table 12.3-1. Classification of effects pathways (no linkage, secondary, and primary) to caribou are also summarized in Table 12.3-1, and detailed descriptions are provided in the subsequent sections.

**Table 12.3-1 Potential Pathways for Effects on Barren-Ground Caribou**

| Project Component / Activity | Effects Pathway | Environmental Design Features and Mitigation | Pathway Assessment |
|---|---|---|---|
| Project Infrastructure and Footprint<br>• access roads<br>• power lines<br>• surface infrastructure and support facilities<br>• open pit<br>• waste rock storage areas<br>• accommodations<br>• dikes | Direct loss and fragmentation of habitat from the Project footprint causes changes in caribou abundance and distribution | • The Project maximizes the use of the existing infrastructure to reduce the environmental footprint to the extent practical.<br>• The new access roads will be as narrow as feasible, while maintaining safe construction and operation practices.<br>• Only one access road crosses the Lac du Sauvage esker.<br>• The Jay WRSA is set back 200 m from the Lac du Sauvage esker.<br>• Kimberlite stockpile areas have been designed in strategic locations that facilitate continued mine operations through various types of road closures.<br>• The Jay power line will parallel the haul road to avoid additional fragmentation and reduce the environmental footprint as much as possible.<br>• Footprints of the WRSAs and other structures will be optimized to limit surface disturbance to the extent practical.<br>• A pipe bench will be constructed to accommodate the pipelines, which will follow existing and proposed road alignments to the extent practical, to minimize the Project footprint.<br>• Soil disturbance will be limited to only those areas required for construction and operation of the Project.<br>• Siting and construction of the Project will be planned to avoid environmentally sensitive areas (e.g., critical wildlife habitat, listed plants and wildlife species, and wetlands) to the extent practical.<br>• Design of the Jay Project minimizes the construction of new buildings, roads, pads, or excavations.<br>• The existing Misery and Lynx pits will be used for dewatering and minewater management, limiting the requirement for additional areas to be altered for minewater management.<br>• Management practices already in place at the Ekati Mine will be implemented to control erosion and sediment.<br>• The existing Ekati Mine ICRP will be amended to include the Project.<br>• Conditions will continue to be monitored over time to evaluate the success of the ICRP and, using adaptive management and newer proven methods as available, adjust the ICRP, if necessary. | Primary |
| Project Infrastructure and Footprint<br>• access roads<br>• power lines<br>• surface infrastructure and support facilities<br>• open pit<br>• waste rock storage areas<br>• accommodations<br>• dikes<br>• exposed lakebed sediments | Physical hazards leading to increased risk of injury or mortality to individual caribou | • The WEMP implemented at the Ekati Mine will include the Jay Project, provide feedback for adaptive management.<br>• The current, effective practices and mitigations for safety of wildlife on roads, airstrip and other areas of the mine will be continued and expanded as necessary to include the Jay Project. These practices include reporting of wildlife sightings by all employees, deterring wildlife from hazardous areas, and control of encounters by Environment staff. | Secondary |

**Table 12.3-1 Potential Pathways for Effects on Barren-Ground Caribou**

| Project Component / Activity | Effects Pathway | Environmental Design Features and Mitigation | Pathway Assessment |
|---|---|---|---|
| General Construction and Operation Activities<br>• mining of the kimberlite pipes<br>• operation of surface infrastructure and support facilities<br>• vehicle traffic along the access road | Air and dust emissions and subsequent deposition can change the quantity or quality of plant forage and alter caribou distribution and behaviour. | • Regular maintenance of equipment will continue at the Ekati Mine.<br>• Dust suppression will be applied, consistent with current practices, to haul roads, the airstrip, and other high traffic areas.<br>• Speed limits will continue to be applied to limit fugitive dust.<br>• Salvaged soil materials stockpiles or exposed soils will be seeded, where necessary, to reduce wind erosion. | Secondary |
| | Ingestion of water, soil, and vegetation, or inhalation of air that has been chemically altered by air emissions or dust deposition may affect wildlife health | • Water quality is monitored and managed through the Water Licence, including the WPKMP, AEMP and SNP. Water quality discharge criteria are provided in the Water Licence, which will be extended to include the Jay Project.<br>• Vegetation and air quality are monitored under the Air Quality Management and Monitoring Program (AQMMP).<br>• Feedback from these monitoring programs can be applied to adaptive management to mitigate effects. | No Linkage |
| | Sensory disturbance (lights, smells, noise, dust, viewscape) and barriers to movement causes changes to caribou movement and behaviour, and changes to energetics and reproduction | • Use of existing surface facilities will limit the area disturbed at construction and limit the quantity of new sensory disturbances.<br>• Only one access road crosses the Lac du Sauvage esker.<br>• The Jay WRSA is set back 200 m from the Lac du Sauvage esker.<br>• Kimberlite stockpile areas have been designed in strategic locations that facilitate continued mine operations through various types of road closures.<br>• The current, effective practices and mitigations for safety of wildlife on roads, the airstrip, and other areas of the mine will be continued and expanded as necessary to include the Jay Project. These practices include reporting of wildlife sightings by all employees, and control of encounters by Environment staff.<br>• A minimum flying altitude of 600 m above ground level (except during takeoff and landing, and during field work) will be maintained for cargo, passenger aircraft, and helicopters outside of the Project site.<br>• Environmental training will be provided for personnel.<br>• The WEMP implemented at the Ekati Mine will include the Jay Project.<br>• Wildlife always have the right-of-way.<br>• Vehicles encountering wildlife on roads will communicate the presence of wildlife on the roads to the Environment Department and others in the area.<br>• Modified traffic patterns and road closures will be used as necessary to protect caribou and people. | Primary |
| General Construction and Operation Activities<br>• operation of surface infrastructure and support facilities<br>• vehicle traffic along the access road | Increased traffic on the Misery Road and Jay Road and the above-ground power line along these roads, may create barriers to caribou movement, change migration routes, and reduce population connectivity | • Only one access road crosses the Lac du Sauvage esker.<br>• Spatially and temporally staged monitoring of the Bathurst caribou herd will be used to track migratory movements via (i) satellite radiocollars, (ii) aerial reconnaissance surveys near the roads, and (iii) road surveys (i.e., advanced information on approaching caribou).<br>• Kimberlite stockpile areas have been designed in strategic locations that facilitate continued mine operations through various types of road closures.<br>• The current, effective practices and mitigations for safety of wildlife on roads, the airstrip, and other areas of the mine will be continued and expanded as necessary to include the Jay Project. These practices include reporting of wildlife sightings by all employees, and control of encounters by Environment staff.<br>• Modified traffic patterns and road closures will be used as necessary to protect caribou and people. | Primary |
| | Collisions between caribou and vehicles or aircraft causes injury or mortality of animals | • Current mitigation includes deterring and removing wildlife from the airstrip.<br>• Speed limits are in place.<br>• Wildlife always have the right-of-way.<br>• Drivers have standard safety training and are provided with awareness training.<br>• Appropriate signage is in place to identify areas of high wildlife use.<br>• Vehicles encountering wildlife on roads are required to stop and communicate the presence of wildlife on the roads to the Environment Department and others in the area.<br>• Wildlife mortalities are monitored and reported, which provides feedback for adaptive management.<br>• Vehicles are restricted to designated roads and prepared work areas (recreational use of off-road vehicles is prohibited).<br>• The current, effective practices and mitigations for safety of wildlife on roads, the airstrip, and other areas of the mine will be continued and expanded as necessary to include the Jay Project. These practices include reporting of wildlife sightings by all employees, and control of encounters by Environment staff. There have been no incidents of caribou mortality caused by vehicle collisions at the Ekati Mine.<br>• Modified traffic patterns and road closures will be used as necessary to protect caribou and people. | Secondary |

**Table 12.3-1 Potential Pathways for Effects on Barren-Ground Caribou**

| Project Component / Activity | Effects Pathway | Environmental Design Features and Mitigation | Pathway Assessment |
|---|---|---|---|
| General Construction and Operation Activities<br>• mining of the kimberlite pipes<br>• operation of surface infrastructure and support facilities<br>• storage of industrial, domestic, hazardous, and contaminated waste<br>• vehicle traffic along the access road | Attractants at site (food, shelter) leading to problem wildlife or increases in predator densities and predation on caribou | • Apply the Waste Management Plan, Landfill Management Plan, and Incinerator Management Plan.<br>• The WEMP is implemented at the Ekati Mine and will be amended to incorporate the Jay Project; wildlife activity will be monitored at waste management areas.<br>• The efficiency of the waste management program will be reviewed regularly and improved through adaptive management where practical.<br>• Separate bins will be located throughout the accommodations complex, shops, and other facilities on-site for immediate sorting of domestic wastes.<br>• Food wastes will be collected in specific bins before transport directly to the incinerator storage area for incineration.<br>• Littering and the feeding of wildlife is prohibited.<br>• Raised, heated buildings will be skirted to prevent wildlife access to shelter.<br>• Education about proper waste management practices and issues surrounding wildlife habituation is provided to all workers and visitors to the site.<br>• Incinerator is enclosed and camp waste will be burned regularly.<br>• Landfill sites and waste storage areas will be inspected.<br>• A chain-link fence is maintained around Misery Camp to prevent wildlife from entering.<br>• Wildlife are deterred from areas of risk. | Secondary |
| General Construction and Operation Activities<br>• operation of the Tibbitt to Contwoyto Winter Road | Continued operation of the Tibbitt to Contwoyto Winter Road results in continued opportunities for harvesting caribou, which can alter caribou movement and behaviour, and survival and reproduction | • Harvest by Non-Aboriginal and Resident hunters is currently regulated by the GNWT ENR, and is currently not permitted along the TCWR or around the Lac de Gras area (hunting zones R/BC/02 and R/BC/03, ENR 2014). | Secondary |
| Site Water Management<br>• dewatering of diked area of Lac du Sauvage<br>• diversions | Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and water levels from the dewatering of diked area of Lac du Sauvage leading to change in riparian habitat and caribou distribution | • Where practical, natural drainage patterns will be unaltered to reduce the use of ditches or diversion berms.<br>• The Sub-basin B Diversion Channel design will consider wildlife passage.<br>• Culverts will be installed along site access roads, as necessary, to maintain drainage.<br>• The road route alignment will minimize stream crossings and limit disturbance to sensitive habitat as feasible.<br>• The Sub-basin B Diversion Channel will be designed to manage flows and minimize potential for erosion and bank instability.<br>• Dewatering and operational discharge will be monitored for downstream erosion, and actions will be taken to prevent erosion in downstream lakes and channels. | No Linkage |
| Site Water Management<br>• dewatering of diked area of Lac du Sauvage<br>• diversions | Dewatering of diked area of Lac du Sauvage may result in newly established vegetation on exposed lakebed sediments, and may change caribou habitat quantity | • None possible, these changes will be temporary (during mine operations only) | Secondary |
| Waste Rock Management | Ingestion of seepage and surface runoff from WRSAs and kimberlite stockpiles, or ingestion of water, soil, and vegetation that has been chemically altered by seepage and surface runoff may affect caribou health | • Metasediment rock mined from the Jay open pit will be encapsulated within a thermally protective cover layer of granite such that metasediment is frozen into permafrost; this method continues the approach that was successfully established at the Ekati Mine for the Misery WRSA.<br>• The existing Ekati Mine WROMP, including seepage monitoring, will be expanded to include the Jay WRSA.<br>• The WPKMP will be amended to incorporate the Jay Project.<br>• Thermistors will be installed within the mine rock piles to monitor permafrost.<br>• Mine rock used to construct the dikes will be non-potentially acid generating (non-PAG).<br>• The WRSA will include a basal layer of non-potentially acid generating (non-PAG) granite that enhances permafrost aggradation and physically separates potentially reactive materials to prevent drainage with low pH. | No Linkage |
| | Surface runoff and seepage from the WRSAs and kimberlite stockpiles may change habitat quality | | No Linkage |

**Table 12.3-1 Potential Pathways for Effects on Barren-Ground Caribou**

| Project Component / Activity | Effects Pathway | Environmental Design Features and Mitigation | Pathway Assessment |
|---|---|---|---|
| General Closure and Decommissioning Activities<br>• Back-flooding of Jay Pit<br>• seepage | Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and water levels from the back-flooding of diked area of Lac du Sauvage alters riparian habitat and caribou distribution | • The existing Ekati ICRP will be expanded to include the Jay Project.<br>• Dike breaching and re-flooding of the dewatered area will be done in a controlled manner so water levels will be equalized on both sides of the dike, and back-flooding will be managed to avoid adverse effects in source waterbodies and downstream.<br>• The diversion channel at the Christine Lake outflow (Sub-Basin B Diversion Channel) will be reclaimed so that water flows through the natural drainage pattern to Lac du Sauvage.<br>• The road route alignment will minimize stream crossings and limit disturbance to sensitive habitat as feasible.<br>• Water quality monitoring for total suspended solids will be completed during the back-flooding period.<br>• During excavation of dike breaches, silt curtains and other sediment and turbidity mitigation will be used as appropriate. | No Linkage |
| | Ingestion of seepage and surface runoff from WRSAs after closure, or ingestion of water, soil, and vegetation that has been chemically altered by long-term seepage and surface runoff may affect caribou health | • Following established Ekati Mine WRSA practices, PAG metasediment rock will be encapsulated within a thermally protective cover layer of granite to facilitate permafrost development.<br>• The existing Ekati Mine WROMP, including seepage monitoring, will be expanded to include the Jay WRSA.<br>• Thermistors will be installed within the WRSA to monitor permafrost. | No Linkage |
| | Long-term seepage from the WRSAs may change habitat quality | | No Linkage |
| Accidents and Malfunctions | Ingestion of soil, vegetation, or water that has been altered by chemical spills (i.e., fuels, petroleum products, reagents, pipelines) on site affecting caribou health | • The existing Spill Contingency Plan in place for the Ekati Mine and will be expanded to include the Jay Project.<br>• Regular equipment maintenance (e.g., regular checks for leaks) will continue.<br>• Drip trays and/or absorbent pads are used during servicing and refuelling.<br>• All hazardous substances are stored and handled on site in accordance with applicable regulations.<br>• Fuel is stored at a central bulk fuel farm at the Ekati Mine main camp, and at satellite fuel farms located at Misery, Fox, and Koala North. Fuel tanks are housed within bermed areas.<br>• The Project will follow existing standard policies in the event of a spill; spill response training is provided and updated.<br>• Soil and snow affected by hydrocarbon spills will continue to be handled in accordance with the existing Hydrocarbon-Impacted Materials Management Plan, and will be remediated in the landfarm or shipped off-site. | No Linkage |
| | | • Mine water and fine processed kimberlite slurry pipelines will be monitored and inspected throughout construction, operations, and closure. Additional mitigation will be applied, if required.<br>• Any leaks or spills identified along the pipelines will be addressed immediately, and clean-up, if required, will be implemented following the existing Spill Contingency Plan. | No Linkage |

WRSA = Waste Rock Storage Area; ICRP = Interim Closure and Reclamation Plan; WPKMP = Wastewater and Processed Kimberlite Management Plan; WROMP = Waste Rock and Ore Storage Management Plan; PAG = potentially acid generating; non-PAG = non-potentially acid generating; km/h = kilometres per hour; m = metre.

DOMINION DIAMOND

#### 12.3.2.2.1 Pathways With No Linkage

A pathway may have no linkage to environmental effects if the activity does not occur, or if the pathway is removed by mitigation or environmental design features so that the Project results in no measurable change in measurement indicators. Subsequently, no residual effect on caribou is expected.
The following pathways have no linkage to caribou and will not be carried forward in the assessment:

- Ingestion of water, soil, and vegetation, or inhalation of air that has been chemically altered by air emissions or dust deposition may affect caribou health.
- Ingestion of seepage and surface runoff from waste rock storage areas (WRSAs) and kimberlite stockpiles, or ingestion of water, soil, and vegetation that has been chemically altered by seepage and surface runoff may affect caribou health.
- Ingestion of seepage and surface runoff from WRSAs after closure, or ingestion of water, soil, and vegetation that has been chemically altered by long-term seepage and surface runoff may affect caribou health.

Surface runoff and seepage from potentially acid generating (PAG) mine rock can change groundwater, surface water, soil and vegetation, and caribou health. Local and traditional knowledge identified health risks to caribou from contaminants as a primary concern (Section 12.2.3). Surface runoff and seepage quality will be monitored on-site according to Water Licence requirements, and the existing Ekati Mine Waste Rock and Ore Storage Management Plan (WROMP) and Wastewater and Processed Kimberlite Management Plan (WPKMP), which will be expanded to incorporate the Jay Project. Long-term monitoring of existing waste rock piles at the Ekati Mine have shown that water seepage has typically met water quality criteria.

Waste rock from the Jay Pit and from dike construction will be stored in the new Jay WRSA. Adaptive management will be applied to the Project to manage seepage and runoff from the WRSAs and kimberlite stockpiles if necessary.  Seepage quality will be monitored and reported to the Wek'èezhìi Land and Water Board as part of the requirements set out in the Water Licence The Jay WRSA will be constructed following previous Ekati Mine WRSA practices to facilitate permafrost development. Any PAG waste rock removed from the Jay Pit will be encapsulated for closure within a thermally protective cover of non-potentially acid generating material (in this case 5 m of granite rock). The WRSA will be monitored for long-term thermal performance as part of existing monitoring programs under the WROMP and Interim Closure and Reclamation Plan (ICRP).

Processing of the Jay kimberlite will generate processed kimberlite. The Panda and Koala open pits are the primary deposition locations for processed kimberlite resulting from the Project (Section 3.5.6).
The use of mined-out open pits for processed kimberlite deposition has generally been acknowledged as a preferred approach, as outlined in the original Environmental Assessment in 1995 (Section 3.5.6).

The Jay WRSA will be stabilized according to the methods described in the Ekati Mine ICRP, and will focus on providing a thermally protective surface cover over PAG materials, providing a relatively flat upper surface that discourages snow accumulation, and providing for caribou emergency egress ramps.

Overall, leaching of PAG mine rock and release of seepage and surface water runoff from the WRSA and kimberlite storage facilities, and long-term seepage from the WRSA is not expected to result in a measurable change to caribou health. Dominion Diamond is committed to completing an ecological risk assessment to determine the potential for adverse effects on wildlife population health associated with exposure to chemicals from the Project. Sources that will be considered in the assessment include fugitive dust, air emissions, surface water runoff, seepage from facilities, and discharge. Potential exposure pathways will include changes in air, water, soil, and vegetation quality, and bioaccumulation of chemicals.

A similar risk assessment for the Gahcho Kué Project determined that there would be no impact to caribou (De Beers 2012). Monitoring and a screening-level risk assessment at the Diavik Mine also indicate that metal concentrations in lichens are expected to have no adverse effects on caribou health (Golder 2011b, 2014c). Based on the results of these assessments, it is predicted that the Project will have no influence on the health of caribou populations. Furthermore, this prediction will be verified with the completion of the ecological risk assessment for the Project during the Environmental Assessment Review process.

- Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and water levels from the dewatering of the diked area of Lac du Sauvage alters riparian habitat and caribou distribution.
- Changes in surface flows (e.g., isolation and diversion, altered drainage patterns) and water levels from the filling of the diked area of Lac du Sauvage alters riparian habitat and caribou distribution.

Dewatering of part of Lac du Sauvage and diversion of headwater flows from tributaries that flow into this area are required for the Project. The location of the proposed Jay Pit currently receives runoff from Sub-basin B and a small portion of the Lac du Sauvage main watershed. To divert water away from the proposed Jay Pit, the Sub-basin B Diversion Channel will be constructed to divert water to Lac du Sauvage outside the dewatered area. Changes in water levels in Lac du Sauvage beyond the natural range of variation could lead to a loss of soils through erosion, and could change the quantity and quality of wetland riparian vegetation (Section 11.3.2.2), which would change associated caribou habitat. Changes in inflows and outflows (e.g., altered drainage patterns, flow velocities) from alteration in water levels in Lac du Sauvage could also affect riparian vegetation downstream (Section 11.3.2.2).

Dewatering of the diked area to Lac du Sauvage is expected to temporarily increase the lake water level and outflow. During construction, the largest changes to Lac du Sauvage would result from dewatering discharge. The dewatering phase modelling predicts an increase of up to 0.05 m in the water level in Lac du Sauvage compared to median baseline conditions, and an increase in the 2-year daily peak flood discharge of approximately 10% compared to baseline conditions (Section 8.5.3.2). Discharge flow rates will be managed to reduce the potential for soil loss through erosion and changes to riparian habitat.

At closure, the back-flooding of the Jay Pit is predicted to result in a decrease in Lac du Sauvage water levels of up to 0.06 m (Section 8.5.3.2). Back-flooding will be managed to minimize adverse effects in source waterbodies and downstream. Following back-flooding of the Jay Pit, baseline water levels in Lac du Sauvage are anticipated to be re-established. The riparian (shoreline) and littoral (shallow) areas around the perimeter of Lac du Sauvage at the re-established water elevation will be reclaimed where necessary to enable natural regrowth of riparian and aquatic vegetation. The reclamation work is expected to include localized repair of erosion, and re-vegetation of select areas with aquatic and riparian plants as necessary. This work will be based on experience gained through operations and closure of other areas of the Ekati Mine.

The cumulative effects from overlapping activities for the Ekati and Diavik mines are within the Lac de Gras watershed downstream of the Lac du Sauvage sub-basin. Negligible effects to surface hydrology from Ekati Mine closure and Diavik Mine operational and closure activities are expected for Lac du Sauvage. Based on modelling results, the maximum annual change to the average Lac du Sauvage mean discharge is predicted to be less than 0.02% and the maximum annual change to the Lac du Sauvage mean water levels are predicted to be less than 0.001 m for the period of 2016 to 2037 (Section 8.5.3.3).

The largest cumulative increase in Lac de Gras outlet flows predicted is during Project dewatering and the back-flooding of the Fox Pit, and Diavik operational activities during 2019. Modelling results predicted a less than 1% cumulative increase in the mean annual discharge and a 0.001 m cumulative increase in the mean annual water levels as compared to baseline conditions (Section 8.5.3.3). The largest cumulative decrease in Lac de Gras outlet flows is predicted to occur during the back-flooding of the diked area in Lac du Sauvage in 2032. Modelling results predicted a 5% cumulative reduction in the mean annual discharge and a 0.04 m cumulative reduction in the mean annual water levels as compared to baseline conditions (Section 8.5.3.3). Cumulative effects to Lac de Gras outlet flows and water levels in an average climate year are within the range of natural variability

Environmental design features and mitigation will be implemented to limit loss of soils through erosion, and to reduce the changes in the quantity and composition of wetland and riparian plant communities from dewatering and back-flooding the diked area in Lac du Sauvage. Lac du Sauvage water levels and Lac du Sauvage outflow discharges will be monitored, and pit back-flooding rates may be adjusted during low water years. Cumulative changes in Lac du Sauvage and Lac de Gras are predicted to be temporary and within the range of natural variability. Minor changes in soil moisture distribution, and composition and abundance of riparian vegetation are expected (Section 11.3.2.2). These minor and localized alterations in riparian vegetation composition and distribution are predicted to result in no measurable changes to the abundance and distribution of caribou. Therefore, these pathways were determined to have no linkage to the caribou population.

- Surface runoff and seepage from WRSAs and kimberlite stockpiles may change habitat quality.
- Long-term seepage from the WRSAs may change habitat quality.

Surface runoff and seepage from WRSAs and kimberlite stockpiles, and long-term seepage from waste rock can change groundwater, surface water, and soil quality, which can affect vegetation and wildlife habitat quality. Local and traditional knowledge identified effects on caribou habitat from chemicals as a concern (Section 12.2.3). Acid rock drainage and metal leaching can result from chemical weathering of minerals present in rock exposed during construction and mining. When PAG rock is exposed to the atmosphere, oxidation of sulphide minerals can produce acidic compounds, sulphate, and metals. Metasedimentary and diabase rock are considered PAG because they contain trace amounts of sulphide minerals. Approximately 25% of waste rock from the Jay Pit will be metasedimentary, with minor amounts of diabase (Section 3.2.2). The remaining 75% of waste rock from the Jay Pit will be granite, which is non-potentially acid generating and non-metal leaching.

Waste rock from the Jay Pit will be stored in the new Jay WRSA. The existing WROMP will be expanded to incorporate the Jay WRSA. Seepage quality will be monitored and reported to the Wek'èezhìi Land and Water Board as part of the requirements set out in the Water Licence. The Jay WRSA will be constructed following existing Ekati Mine WRSA practices to facilitate permafrost development. Any PAG waste rock removed from the Jay Pit will be encapsulated for closure within a thermally protective cover of non-potentially acid generating material (in this case 5 m of granite rock). The WRSA will be monitored for long-term thermal performance as part of existing monitoring programs under the WROMP and ICRP.

The Panda and Koala open pits are the primary deposition locations for processed kimberlite resulting from the Project (Section 3.5.6). The use of mined-out open pits for processed kimberlite deposition has generally been acknowledged as a preferred approach, as outlined in the original Environmental Assessment in 1995 (Section 3.5.6).

Changes to groundwater, surface water, and soil quality from surface runoff, seepage, and long-term seepage from leaching of PAG mine rock in the WRSA and from the kimberlite storage facilities is expected to be limited through the use of mitigation and Project design features. No changes to vegetation are predicted (Section 11.3.2.2). Therefore, these pathways were determined to have no linkage to caribou.

- Ingestion of soil, vegetation, or water that has been chemically altered by chemical spills (e.g., fuel, reagents, pipelines) on site affecting caribou health.

Accidental spills from equipment, storage areas, and pipelines could affect caribou health. Effects on caribou health from chemicals has been identified as a concern by local and traditional knowledge (Section 12.2.3). Water will be transferred between mine water management areas via pumping and pipeline systems. Mitigations and management identified in the existing WPKMP and environmental design features will be in place to limit the potential for pipeline failure. The integrity and performance of the pumping and pipeline systems will be monitored throughout the Project construction and operations phases to prevent the unintentional release of minewater to the environment. If any leaks and spills occur from the pipeline, clean-up will follow existing procedures in place at the Ekati Mine.

Chemical spills have not been reported as the cause of wildlife mortality at the Ekati, Diavik, or Snap Lake mines, or the Jericho Diamond Project (Jericho Mine) (Tahera 2007; Golder 2013, 2014a,b; ERM Rescan 2013a). Large ruptures or leaks in pipelines have also not been observed. Chemical spills are usually localized, and are quickly reported and managed. The implementation of proven mitigation practices identified in the existing Spill Contingency Plan, WPKMP, and environmental design features are expected to result in no measurable change to the health of caribou.

##### *12.3.2.2.2 Secondary Pathways*

In certain cases, a source and a pathway exist, but because the change caused by the Project is anticipated to be minor relative to the Base Case, it is expected to have a negligible residual effect on caribou. The pathways described in the following bullets are expected to be secondary and will not be carried forward in the assessment.

- Physical hazards leading to increased risk of injury or mortality to individual caribou.

The presence of physical hazards on-site may result in an increased frequency of injury or mortality to caribou. From 1996 to 2013 there was a total of 12 mine-related caribou mortalities at the Diavik, Ekati, and Snap Lake mines (Section 12.2.2.4). Two animals were intentionally destroyed, seven had been entangled in fences (Section 12.3.2.1.2), and three died after becoming stuck in exposed lakebed sediments. No reported injuries or mortalities have been related to open pits, fly rock, and waste rock piles. The fence around the Ekati airstrip was replaced in August 2010 with a construction and safety barrier fence to avoid further fence-related caribou mortalities at the airstrip. The implementation of environmental design features (Table 12.3-1) and actions identified through the Wildlife Effects Monitoring Plan (WEMP) are expected to further decrease the risk to animals from physical hazards on-site. Mitigations will include the following:

- Roads and the Sub-Basin B Diversion Channel will be constructed with caribou crossings that reduce risk of injury related to coarse road fill.
- Blasting in the pit and quarry, if necessary, will be carefully planned and controlled to minimize fly rock that might injure caribou.
- The use of guy wires for power poles will be minimized as much as feasible, and those guy wires that are required will be made more visible with coloured plastic sleeves to reduce risk of injury to caribou.
- Ramps to facilitate the access and egress of wildlife from the WRSAs will be constructed for closure.

A portion of Lac du Sauvage will be dewatered so that the Jay Pit can be mined. The dewatered portion of Lac du Sauvage will be contained within the Jay Pit dike. Although exposed lakebed sediments could potentially trap and cause injury or mortality to caribou, this interaction is not expected at the Project because animals are unlikely to enter the Jay Pit dike area. The dike is anticipated to physically deflect caribou movement, and the high amount of human activity in the dike area is likely to result in avoidance of the area by caribou. Also, exposed lakebed sediments in the dewatered portion of Lac du Sauvage will form a hardpan crust, which will reduce the risk of caribou getting trapped in the sediments if animals do enter the dike area. Wildlife deterrent actions will be implemented by knowledgeable and trained personnel. The goal of these deterrents is to manage wildlife encounters in ways that will keep both humans and animals safe.

Although there is a potential for mortality or injury to occur, the implementation of proven successful mitigation (Section 12.3.2.1), environmental design features, and the WEMP to provide ongoing monitoring information is anticipated to reduce the risk to caribou mortality from physical hazards on-site and exposed lakebed sediments. Changes in mortality are predicted to be minor relative to the Base Case (Table 12.3-1). As such, mortality from physical hazards on-site and exposed lakebed sediments is expected to have a negligible residual effect on caribou populations.

- Air and dust emissions and subsequent deposition can change the quantity or quality of plant forage and alter caribou distribution and behaviour.

Local and traditional knowledge have identified dust as a concern for caribou food, particularly effects on lichens (Section 12.2.3). Construction and operation of the Project will generate air emissions such as carbon monoxide (CO), oxides of sulphur (SOx includes sulphur dioxide [$SO_2$]), oxides of nitrogen (NOx), particulate matter ($PM_{2.5}$), and total suspended particulates (TSP). Air emissions such as SOx and NOx can result from the use of fossil fuels in generators, vehicles, machinery, and explosives. The deposition of air and dust emissions can lead to changes in soil and vegetation quality by altering soil pH and nutrient content, and soil fauna composition (Section 11.3.2.2.2). Deposition of SOx and NOx can also have direct effects on plant communities (Section 11.3.2.2.2).

Roads that are used to access the Project and the dewatered diked area in Lac du Sauvage are the main source of dust ($PM_{2.5}$ and TSP) due to the re-suspension of soil and sediment particles (Section 11.3.2.2.2). Accumulation of dust (i.e., TSP deposition) may result in a local direct change on the quantity, distribution, and quality of vegetation near the Project.

Air quality modelling was completed to predict the spatial extent of air and dust emissions and deposition from the Project (Section 7.4). Modelling was completed for the Base Case and Application Case. The Base Case includes emissions from the existing Ekati Mine and the Diavik Mine (Section 7.4.1). The Application Case includes the Base Case plus emissions during a worst case operations year and provides the maximum potential effects from the Project. Assumptions were incorporated into the model to contribute to conservative estimates of emission concentrations and deposition rates.

Results of the air quality modelling indicate that the maximum ground-level concentrations of CO and SOx, are below the Northwest Territories Ambient Air Quality Standards (GNWT-ENR 2014; Section 7.4.2.2). The maximum 1-hour and annual $NO_2$ concentrations are above the NWT standard in both the Base Case and Application Case. The maximum 24-hour $NO_2$ concentrations in the Base Case are below the NWT standard but above the standard in the Application Case. All predictions exceeding the NWT standards are confined to small areas within a few hundred metres from the edge of the Diavik Mine or Jay Pit. These higher predictions are primarily a result of mine fleet exhaust along the haul roads at the perimeters of the mine sites. The predicted concentrations decrease with distance from the edge of the mine sites.

Modelling results indicate that the maximum annual potential acidic inputs is 1.46 kiloequivalents per hectare per year (keq/ha/yr), and is associated with the boundary of the Jay Pit. The Project's maximum annual potential acidic input outside of the Project footprint is predicted to be between 0.17 keq/ha/yr to 0.5 keq/ha/yr, with values dropping below 0.17 keq/ha/yr within 1 km of the Project. The sensitivity of soils to acidification is low to medium; therefore, it is expected there will be no change to soils from acidification, and subsequently no effects on vegetation (Section 11.3.2.2.2).

The maximum annual $PM_{2.5}$ emissions resulting from the Project is 39.4 micrograms per cubic metre ($\mu g/m^3$), which is above the NWT air quality standard of 10 $\mu g/m^3$. The maximum annual TSP emissions resulting from the Project is 607 $\mu g/m^3$, which is above the annual NWT air quality standard of 60 $\mu g/m^3$. The maximum annual totals are predicted to be confined to the boundaries of the existing Ekati Mine, the Jay Pit and the Diavik Mine. The area with $PM_{2.5}$ and TSP above the annual NWT air quality standards extends no further than approximately 1 km beyond the sources. In addition, because of the conservatism used for the air quality modelling, it is expected that the actual $PM_{2.5}$ and TSP concentrations at the Project will be lower than predicted, closer to the concentrations currently measured at the Ekati Mine.

Dust on vegetation can result in a reduction of plant growth and biomass, and can alter species composition (Section 11.3.2.2.2). Sources of dust deposition modelled in the Application Case include blasting activities, the processing plant, activities at the open pit and other ancillary facilities, the exposed lake bed sediments, the air strip, and vehicle traffic along the mine roads (Section 7.4). The results of the air quality modelling predicted that the estimated deposition rate outside of the Project footprint is approximately 4,722 kg/ha/y. The maximum deposition that occurs would be mostly associated with the Jay Pit and haul roads. This conservative estimate is equivalent to 1.29 grams per square metre per day ($g/m^2/d$). Dust production and deposition would likely be higher during the non-winter period, but would occur less frequently during wet and cool conditions. Lichens and mosses that derive some of their moisture and nutrient requirements from the atmosphere can be sensitive to the effects of dust (Section 11.3.2.2.2). For example, *Sphagnum* along a gravel road in the Alaskan tundra have been observed to have decreased photosynthetic rates and a decline in cover when dust deposition was 1.0 to 2.5 $g/m^2/d$ (Farmer 1993). Although there was a decline in *Sphagnum* cover, it was replaced by more tolerant mosses such as haircap moss (*Polytrichum* spp.) and Bryum moss (*Bryum* spp.) (Farmer 1993). Auerbach et al. (1997) found that, although plant species composition may change and aboveground biomass may be reduced by dust deposition, ground cover is still maintained. Long-term monitoring at the Diavik mine indicates that dust deposition adjacent to the mine has resulted in statistically lower lichen cover and higher vascular plant species richness relative to reference plots (Golder 2014c).

The area receiving dust deposition extends no further than approximately 1 km beyond the Project footprint. This is to be expected, as in general the majority of dust tends to settle out within 1 km of ground-level sources, which are the primary sources of TSP at the Project (Section 11.3.2.2.2). Environmental design features and mitigation have been incorporated into the Project to reduce potential effects from dust deposition (Table 13.3-1). For example, dust suppression will be applied as appropriate to roads, airstrip, and laydown areas and speed limits are established on all roads to reduce the production of dust. These environmental design features and mitigation, which should reduce dust deposition, have not been incorporated into the modelling; thus, the modelling results provide conservative estimates of deposition rates (Section 7.4). Because of the conservatism used for the air quality modelling, it is expected that the actual dust deposition from the Project will be lower than predicted, closer to the concentrations measured currently at the Ekati Mine. In addition, because the result represents the emissions during worst case operations year (i.e., during initial blasting of the Jay Pit), once mining activities advance, it is expected that dust will no longer be emitted outside of the Jay Pit. The amount of dust deposition will decrease substantially.

Overall, air and dust emissions and subsequent deposition are expected to result in minor changes to soil and vegetation quality. Localized alterations in plant forage quantity or quality are predicted to result in minor changes to the abundance and distribution of caribou populations relative to Base Case conditions. Therefore, this pathway was determined to have a negligible residual effect on self-sustaining and ecologically effective caribou populations.

- Collisions between caribou and vehicles/aircraft cause injury or mortality of animals.

There is potential for an increase in the risk of injury or death to caribou through collisions with aircraft, on-site vehicles, and traffic along the TCWR and on roads at the Ekati Mine.

Similar to other mining operations in the region, access to the Project in the winter will be via the TCWR. Traffic volume on the TCWR increased from 3,703 loaded (northbound) trucks in 2000 to 10,922 loaded trucks in 2007 (Table 12.3-2; TCWR Joint Venture 2013a). Traffic volume on the TCWR decreased during 2008 through 2013 (6,071 northbound loads in 2013; TCWR Joint Venture 2013a,b).

**Table 12.3-2 Operating Period and Number of Northbound and Southbound Truck Loads on the Tibbitt to Contwoyto Winter Road, 2000 to 2013**

| Year | Operating Period | Number of Northbound Trucks | Number of Southbound Backhauls |
|---|---|---|---|
| 2000[(a)] | January 29 to April 3 | 3,703 | 135 |
| 2001[(a)] | February 1 to April 13 | 7,981 | 201 |
| 2002[(a)] | January 26 to April 16 | 7,735 | 433 |
| 2003[(a)] | February 1 to April 2 | 5,243 | 883 |
| 2004[(a)] | January 28 to March 31 | 5,091 | 165 |
| 2005[(a)] | January 26 to April 5 | 7,607 | 243 |
| 2006[(a)] | February 5 to March 26 | 6,841 | 469 |
| 2007[(a)] | January 27 to April 9 | 10,922 | 818 |
| 2008[(a)] | January 29 to March 31 | 7,484 | 890 |

**Table 12.3-2 Operating Period and Number of Northbound and Southbound Truck Loads on the Tibbitt to Contwoyto Winter Road, 2000 to 2013**

| Year | Operating Period | Number of Northbound Trucks | Number of Southbound Backhauls |
|---|---|---|---|
| 2009[a] | February 1 to March 22 | 4,847 | 530 |
| 2010[a] | February 4 to March 24 | 3,506 | 424 |
| 2011[a] | January 28 to March 31 | 6,832 | 530 |
| 2012[a] | February 1 to March 31 | 6,551 | 648 |
| 2013[b] | January 30 to March 31 | 6,071 | 454 |

a) Source: TCWR Joint Venture (2013a).

b) Source: TCWR Joint Venture (2013b).

The predominant factors that contribute to road-related wildlife deaths are traffic volume and vehicle speed (EBA 2001). These factors directly affect the success of an animal reaching the opposite side of the road. An increase in either factor reduces the probability of an animal crossing safely (Underhill and Angold 2000). However, implementation of the Winter Road Policy, Rules and Procedures for the TCWR is anticipated to reduce the potential for injury/mortality of wildlife from vehicle collisions (TCWR Joint Venture 2000). For example, from 1996 to early winter 2014, there have been seven reported road-related caribou mortalities along the TCWR. In March 1999, five caribou were killed by a grocery (meat) truck on a portage near Gordon Lake (EBA 2001). In January 2014, two caribou were killed by a haul truck (Near 2014).

Mitigation strategies have been established to reduce the potential for caribou and vehicle or aircraft collisions at the Ekati Mine (Table 12.3-1). There have been no caribou mortalities at the Ekati Mine related to vehicle collisions over the 16 years of operations (1998 to 2014), indicating that the risk mitigation practices are effective. These practices have evolved over time to a high degree of effectiveness in this regard. The following environmental design features and mitigation are expected to limit the risk from vehicle and aircraft collisions with caribou at the Ekati Mine:

- wildlife have the right-of-way;
- road design limits blind spots where possible to reduce the risk of accidental wildlife-human encounters;
- speed limits are established; and,
- drivers will be alerted using signage and radio when wildlife are moving through an area, and speed limits will be further reduced as appropriate.

Based on the success of mitigation and management practices used at the Ekati Mine and on the TCWR, the environmental design features and mitigation implemented for the Project are anticipated to limit caribou mortality from vehicle and aircraft collisions relative to Base Case conditions. As such, mortality from vehicle and aircraft collisions is expected to have a negligible residual effect on a self-sustaining and ecologically effective caribou population.

- Attractants at site (food, shelter) leading to problem wildlife or increases in predator densities and predation on caribou.

Food smells and other aromatic compounds such as petroleum-based chemicals, grey water, and sewage can attract carnivores to human developments (Benn and Herrero 2002; Peirce and Van Daele 2006; Canadian Wildlife Service 2007; Beckmann and Lackey 2008). Members from the NSMA and KIA have voiced concerns about grizzly bears being attracted to mines because of smells (Section 13.2.3). In addition, infrastructure may also attract carnivores because it can serve as a temporary refuge to escape extreme heat or cold (Canadian Wildlife Service 2007).

Wildlife effects monitoring programs completed at the Ekati Mine (2000 through 2013), the Diavik Mine (2002 through 2013), the Jericho Mine (2000, 2005 through 2007), and the Snap Lake Mine (2001 through 2013) have reported attractants (e.g., non-burned food items, oil products, and food packaging) in the landfill. However, most of the animals and sign observed during these landfill surveys were associated with foxes (Section 13.2.2.7). Grizzly bears, wolverine, and wolf tracks were occasionally observed. Attraction of predators to the Project can increase predation pressure on caribou.

Environmental design features and mitigation strategies have been established to reduce the numbers of carnivores attracted to the Project (Table 12.3-1). A Waste Management Plan as approved by the Wek’èezhìi Land and Water Board is in place that works in concert with the WEMP to effectively manage various types of wastes, including wildlife attractants. These strategies include the following:

- Workers and visitors to the site are educated about the importance of proper waste management practices.
- People are educated on the risks associated with feeding wildlife and careless disposal of food garbage.
- Separate bins are located throughout facilities on-site for immediate sorting of domestic waste.
- Food waste is stored inside for transport directly to the incinerator for incineration.
- Incinerator ash from combustion of kitchen and office waste is stored inside and transported to the landfill.
- The landfill is covered regularly with crushed or mine rock.
- Ongoing review of the efficiency of the waste management program and improvement through adaptive management.

Based on the success of mitigation and management practices used at the Ekati Mine, the environmental design features and mitigation implemented for the Project are anticipated to limit the attraction of carnivores to the site and result in minor changes to predator-caribou relationships relative to Base Case conditions. Subsequently, this pathway is expected to have a negligible residual effect on the caribou populations.

- Continued operation of the TCWR results in continued opportunities for harvesting caribou, which can alter caribou movement and behaviour, and survival and reproduction

The Project is dependent on the TCWR for hauling fuel, mining equipment and other supplies during construction, operation and closure. Historically, harvesting of caribou from the TCWR was permitted, and monitored by ENR at a checkpoint that relied on voluntary reporting. The number people using the TCWR to harvest caribou ranged from a high of approximately 2300 in 2004, to a low of approximately 500 in 2011 (ENR 2011).

The harvest of caribou by Non-Aboriginal and Resident people is regulated by the GNWT-ENR, and is currently not permitted along the TCWR or around the Lac de Gras area (hunting zones R/BC/02 and R/BC/03, ENR 2014). This has been the case since December 2009 when interim emergency actions were put in place to help conserve the Bathurst herd. Beginning in 2011, harvesting by General Hunting Licence holders has been set at a voluntary limit of 300 per year, divided among the Tłı̨chǫ and Yellowknives Dene. Some of this harvest has occurred along the TCWR.

Continued operation of the TCWR from the Jay Project is expected to result in a minor change to the harvest of caribou, and associated alteration in caribou movement, behaviour and survival and reproduction relative to Base Case conditions. The end of operation and closure of the Project is anticipated in 2029 and 2033, respectively. The Diavik Mine is expected to complete operation in 2023, while the end of operation for the Snap Lake Mine is scheduled to occur in 2029. The Gahcho Kué Project is anticipated to begin interim closure in 2027. Thus, the Jay Project is predicted to increase the operation of the TCWR by 4 to 5 years after closure of the Gahcho Kué Project and Snap Lake Mine, which should have a negligible effect on caribou populations. Although there is uncertainty in the actual closure of mines and the population status of caribou 15 to 20 years into the future, it is expected that similar regulations regarding the harvesting of caribou along the TCWR would be implemented, if required.

- Dewatering of diked area of Lac du Sauvage may result in newly established vegetation on exposed lakebed sediments and could change caribou habitat quantity.

It is expected that vegetation will colonize the dried dewatered areas within the diked area, which may reduce potential for soil erosion, and could result in an increase in plant communities in this area (Section 11.3.2.2). Odland and del Moral (2002) found that vegetation, primarily annuals, rapidly established in areas of drawdown and was a result of the persistent seed bank present in the soil. The primary influence of plant colonization on a lake bed is the condition of the surface (e.g., moisture status, resistance to wind erosion) and proximity to the former shoreline (Ovenden 1986). Species commonly observed to colonize disturbed and drawdown areas often include the genera *Carex*, *Puccinellia*, *Arctagrostis*, *Calamagrostis*, *Epilobium*, and *Polytrichum* (Ovenden 1986; Kershaw and Kershaw 1987; Odland and del Moral 2002; Hugron et al. 2011).

Establishment of vegetation on exposed lake sediments within the diked area of Lac du Sauvage has the potential to provide habitat for caribou that may access the diked area, although it is expected that caribou would likely avoid the area during open-pit operations because of the close proximity to mine operations and due to limited accessibility into this area. During closure, filling of the open pit and breaching of the dike would remove vegetation and associated caribou habitat that may have established during operations. Overall, the localized establishment of vegetation in the diked area during the operation of the Project is predicted to result in a minor change in habitat quantity relative to Base Case conditions, and a negligible effect on caribou.

#### *12.3.2.2.3 Primary Pathways*

The following primary pathways are assessed in detail in the residual effects analysis (Section 12.4):

- Direct loss and fragmentation of habitat from the Project footprint causes changes in caribou abundance and distribution.
- Sensory disturbance (lights, smells, noise, dust, viewscape) and barriers to movement causes changes to caribou distribution and behaviour, and changes to energetics and reproduction.
- Increased traffic on the Misery Road and Jay Road and the above-ground power line along these roads may create barriers to caribou movement, change migration routes, and reduce population connectivity.

## 12.4 Residual Effects Analysis

### 12.4.1 General Approach

The effects analysis considers all primary pathways that result in expected changes to the population size and distribution of caribou from the Project after implementing environmental design features and mitigation actions. Barren-ground caribou populations with ranges that overlap or may overlap the effects study area (ESA) of the Project are the Bathurst, Ahiak, and Beverly herds (Table 12.2-4). Satellite collar data from 1996 to October 2013 indicates that the Bathurst herd has the greatest likelihood of interacting with the Project during the spring, post-calving, and autumn periods (Table 12.2-4). Satellite collar data collected for the Ahiak herd (2001 to October 2013) suggest that individuals from the Ahiak herd may occur in the BSA during the spring and autumn periods (Table 12.2-4). No satellite collar locations from the Beverly herd were recorded in the BSA (Table 12.2-4).

Because the Bathurst herd has the greatest likelihood of interacting with the Project, emphasis in the effects analysis is on the Bathurst population. In addition, current knowledge and relevant information regarding caribou research in the North Slave Region is focused on the Bathurst herd (Section 12.2.2). Therefore, potential Project-related effects predicted for the Bathurst herd are anticipated to be representative and provide conservative estimates of effects for the Ahiak and Beverly herds (i.e., the effects for the Bathurst herd will likely overestimate effects for the Ahiak and Beverly herds).

Residual effects on Bathurst caribou are analyzed using measurement indicators (e.g., habitat quantity and fragmentation, habitat quality, survival, and reproduction). Changes in habitat quality, movement, and behaviour include influences from noise, lights, dust deposition, viewscape), and the presence of vehicles and people. The combination of direct (physical footprint) and indirect (noise, dust, viewscape and other sensory disturbances) effects can create a ZOI around the Project that can change the behaviour and occurrence of caribou (Section 12.2.2.2).

Changes in the quantity and quality of habitat within the ZOI can influence the number of animals that the landscape is able to support (i.e., carrying capacity). If animals strongly avoid human development, then the use of less disturbed areas may become higher and more concentrated. Changes to behaviour (such as decreased time spent feeding or increased time spent moving away from disturbance) within the ZOI can influence the energy balance of caribou and alter survival and reproduction. These changes can ultimately affect caribou population size and distribution.

The spatial scale of the analysis considers natural and human-related effects that occur within the seasonal ranges of caribou. Seasonal ranges for the Bathurst caribou herd were calculated using satellite collar data (courtesy of GNWT-ENR) and a 95% kernel density (i.e., probability density) estimate. Range estimates for the Bathurst herd included satellite locations from January 1996 through October 2013. Kernel density analyses were completed independently for each seasonal range of the Bathurst caribou herd. The outer boundary of the four seasonal ranges for the Bathurst caribou herd collectively define the ESA (Section12.1; Figure 12.1-2).

The temporal scale includes natural and development-related changes from reference conditions (no to little development) through application of the Project and reasonably foreseeable developments (effects from potential future projects are discussed in Section 12.4.1.4). Base Case conditions represent a range of temporal values on the landscape from reference to 2014 baseline conditions. Environmental conditions on the landscape before industrial development (i.e., reference conditions) are considered part of the Base Case, as the baseline represents a range of conditions over time, and not just a single point in time (Section 12.4.1.2). Analyzing a range of temporal conditions on the landscape is fundamental to understanding the cumulative effects of increases in development on caribou populations.

The effects analyses determine the incremental and cumulative changes from the Project and other developments on the landscape and caribou. Incremental effects represent the Project-specific changes relative to baseline condition values in 2014 (current or existing conditions). Project-specific effects typically occur at the local scale and represent the predicted maximum spatial extent of effects (i.e., ZOI).

Cumulative effects are the sum of all changes from reference conditions through application of the Project and future developments. In contrast to Project-specific (incremental) effects, cumulative effects occur across the range of the population (i.e., beyond local scale) as caribou travel large distances during their seasonal and annual movements, and can be affected by the Project and several other developments (Section 6.4 and 6.6). In other words, the combined local effects from the Project and other developments that overlap with the distribution of the Bathurst caribou population result in regional-scale effects.

Cumulative effects are not simply the combined effects from human development on caribou populations; they represent the sum of all natural and human-induced influences on the landscape and caribou populations through time and across space. Some changes may be human-related, such as increasing development or hunting pressure. Other changes may be associated with natural phenomena such as extreme insect harassment years, and periodic harsh and mild winters. The objective of the cumulative effects analysis is to predict the relative contribution of human-related influences on the Bathurst herd in context of natural factors.

Detailed descriptions of the spatial and temporal boundaries, and methods used to analyze residual effects from the Project on caribou are provided in the following sections. The analyses were quantitative, where possible, and included data from field studies, scientific literature, government publications, effects monitoring reports, and personal communications. Traditional knowledge and community information were incorporated where available. Owing to the amount and type of data available, some analyses were qualitative and included professional judgement or experienced opinion.

#### 12.4.1.1 Project Phases

The Project phases include construction, operations, and closure. Final closure of the Project generally occurs after the completion of reclamation. Many effects of the Project will end when operations cease or at closure, but effects on caribou will continue after Project closure.

The effects analysis encompasses the following Project phases:

- construction (2016 to 2019);
- operations (2019 to 2029); and,
- closure (2030 to 2033).

The above timeframes are intended to be sufficiently flexible to capture the effects of the Project on caribou. Effects on caribou begin during the construction phase with the removal and alteration of habitat, and continue through the operations phase and for a period of time into the closure phase (unless determined to be permanent). Therefore, effects on caribou were analyzed and assessed for significance from Project construction through closure. This approach generates the maximum potential spatial and temporal extent of effects on the abundance and distribution of caribou, which provides confident and ecologically relevant effects predictions.

#### 12.4.1.2 Assessment Cases

The residual effects analysis consists of three cases: Base Case, Application Case (the maximum point of development of the Project [includes construction, operations, and closure]), and the Reasonably Foreseeable Development (RFD) Case (Table 12.4-1). Cumulative effects could occur in all three cases owing to past, existing, and future mining and reclamation activities. The objective of the DAR is to assess cumulative effects for VCs where Project effects could contribute to a cumulative effect. Therefore, incremental and cumulative effects of the Project and other developments are analyzed and assessed together in this section of the DAR.

**Table 12.4-1 Contents of Each Assessment Case**

| Base Case | | Application Case | Reasonably Foreseeable Development Case |
|---|---|---|---|
| Reference Condition | 2014 Baseline Condition | | |
| No to little development | Conditions from all previous, existing, and planned approved developments before the Project. | Base Case plus the Project | Application Case plus reasonably foreseeable developments |

**Base Case** represents a range of conditions over time within the effects assessment (study) area before application of the Project. Environmental conditions on the landscape before human development, which represent reference conditions, were considered independently within the Base Case.
The reference condition includes First Nation communities, which are assumed to be part of the historical natural ecosystems. The Base Case also describes the existing environment before the application of the Project to provide an understanding of the current conditions that may be influenced by the Project.

Existing (2014 baseline) conditions include the cumulative effects from all previous and existing developments and activities that are approved, and are either under construction or not yet initiated in the ESA (e.g., Lynx Project). The rusher/laydown area near the Misery Road and Misery WRSA is included in the 2014 baseline condition because it is anticipated to be in use before the Jay Project construction begins. Current (baseline studies) and effects from ongoing projects that are approved (e.g., mining and reclamation at the Ekati and Diavik mines) are also included in the 2014 baseline condition. Previous and existing human developments also include areas of exploration activities and portages associated with winter roads.

**Application Case** represents predictions of the cumulative effects of the developments in the Base Case combined with the effects from the Project. Physical disturbance to vegetation is expected to occur at the beginning of construction, and the effects from the Project are expected to be strongest during construction and the initial period of mining operation. The main components of the Project footprint include the proposed infrastructure (Jay Pit, Jay waste rock storage area [WRSA], ore stockpile and transfer pad, Sub-Basin B Diversion Channel, and dike alignment), and Jay access roads, pipeline, and power line. The physical changes to the terrestrial environment from the Project footprint and the effects on caribou are considered permanent because the time required to reverse the effect is uncertain. The outcome of natural colonization of vegetation with respect to the Project footprint can also be altered by factors such as climate changes and unforeseeable human development. Assuming a ‘permanent’ loss of habitat for the purpose of this environmental assessment is a conservative approach that is not at risk of underestimating effects in this regard. The Application Case is also used to identify the incremental changes from the Project that are predicted to occur between the Base Case and the Application Case.

**Reasonably Foreseeable Development (RFD) Case** represents the Application Case and reasonably foreseeable developments. The RFD Case includes the predicted duration of residual effects from the Project, plus other previous, existing, and future projects and activities. Thus, the minimum temporal boundary for the Application Case and RFD Case is the expected lifespan of the Project, which like the Base Case, includes a range of conditions over time. The RFDs are defined as projects that are as follows:

- currently under regulatory review or have officially entered a regulatory application process;
- have a reasonable likelihood of being initiated during the life of the Project, or may be induced by the Project; and,
- have the potential to change the Project or the effects predictions.

#### *12.4.1.3 Previous and Existing Developments*

Aboriginal Affairs and Northern Development Canada Cumulative Impact Monitoring Program provided the development database through the Inventory of Landscape Change initiative. The data included all disturbances for which information was publicly and digitally available, including developments requiring a land use permit, contaminated sites, transmission lines, winter and all-season roads, communities, and mines up to the end of 2013. The database also included recent land use permit applications from the Mackenzie Valley Land and Water Board and the Nunavut Impact Review Board up to the end of 2013.

Point disturbances in the Inventory of Landscape Change originated from spreadsheet databases of land use permits (except for campgrounds, contaminated sites, mines, and parks), so the locations are not precise. While land use permits are generally issued for five-year spans, information on the duration or seasonality of activity within that five years (or if development proceeded at all) is not recorded by any agency in the NWT or Nunavut. Thus, it was assumed that all developments were active throughout the entire year for all five years following issuance, with the exception of winter roads, which were assumed to be active only in winter. Winter road portages were assumed to be permanent disturbance to the terrestrial landscape. All-season roads include the those roads associated with mines in the seasonal ranges; the all-season road network associated with the Ekati Mine is 60 km of the total in each of the spring, post-calving, and autumn ranges. The assumption that all developments were active throughout the entire five years of the land use permit is conservative because many of these developments (e.g., mineral exploration camps and hunting camps) are only active seasonally.

Because the Inventory of Landscape Change database does not describe the footprint of developments, the physical area of the footprint was estimated (Table 12.4-2). Actual footprints were used for mines and communities. During the spring to fall, only terrestrial habitat that occurred within the 500-m buffer around exploration activity point features was removed; open-water habitat was not removed by exploration activities during the spring to fall. During the winter, terrestrial and open-water habitats were removed within the 500 m around exploration activities. For closed mines and inactive developments, the physical footprint was carried through the entire effects analysis because it was assumed that direct disturbance to the landscape had not yet been reversed. Footprints with overlapping areas on the landscape were not counted twice.

Contaminated site information was provided by the Federal Contaminated Sites Inventory (TBCS 2013). Only sites classified as High and Medium Priority for Action were included. Sites that were classified as Low Priority for Action were considered too small to lead to measureable habitat loss or to have indirect habitat effects.

The data were examined for duplication of information. In cases where two or more pieces of location information were present for the same activity (such as a land use permit for an exploration camp and a second land use permit to expand the fuel cache), the extra information was deleted from the file so that it contained only one point per development. The activity causing the highest level of disturbance was the disturbance that was added to the development database.

The number and type of previous and existing developments in the ESA are listed in Tables 12.4-3 and 12.4-4, and illustrated in Map 12.4-1.

**Table 12.4-2 Estimated and Hypothetical Footprints for Previous, Existing, and Reasonably Foreseeable Developments in the Bathurst Herd Effects Study Area**

| Disturbance Type | Feature Type | Spring, Post-Calving, Autumn Ranges Footprint (m) | Winter Range Footprint (m) |
|---|---|---|---|
| Campgrounds | Point | 250 | 200 |
| Community | Polygon | Actual[(a)] | Actual[(a)] |
| Communications | Point | 250 | 200 |

**Table 12.4-2 Estimated and Hypothetical Footprints for Previous, Existing, and Reasonably Foreseeable Developments in the Bathurst Herd Effects Study Area**

| Disturbance Type | Feature Type | Spring, Post-Calving, Autumn Ranges Footprint (m) | Winter Range Footprint (m) |
|---|---|---|---|
| Contaminated Site – High and Medium Priority[b] | Point | 250 | 200 |
| Fuel Storage | Point | 250 | 200 |
| Mine | Polygon | Actual[a] | Actual[a] |
| Mineral Exploration | Point | 500 | 500 |
| Park | Polygon | Actual[a] | Actual[a] |
| Power | Point | 250 | 200 |
| Quarrying | Point | 250 | 200 |
| Staging Area | Point | 250 | 200 |
| Tourism (e.g., lodges) | Point | 250 | 200 |
| Transmission Line | Line | 250 | 200 |
| All-Season Road | Line | 250 | 200 |
| Winter Road | Line | 250 (portages) | 200 |

Note: Point features were buffered with a circular footprint. Linear features were buffered with a corridor (e.g., 250 m right-of-way).

a) Delineated and digitized from remote sensing imagery.

b) As defined by the Federal Contaminated Sites Inventory (TBCS 2013).

m = metre.

DOMINION DIAMOND

**Table 12.4-3 Previous and Existing Developments in the Bathurst Herd Effects Study Area for the Base Case (Spring, Post-Calving, and Autumn Ranges)**

| Type of Development | Spring Range | | | | Post-Calving Range | | | | Autumn Range | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Footprint Area (ha) | Number of Active Sites | Number of Inactive Sites | Linear Feature Length (km) | Footprint Area (ha) | Number of Active Sites | Number of Inactive Sites | Linear Feature Length (km) | Footprint Area (ha) | Number of Active Sites | Number of Inactive Sites | Linear Feature Length (km) |
| All-Season Road | 2,542 | N/A | N/A | 100 | 2,153 | N/A | N/A | 85 | 2,446 | N/A | N/A | 96 |
| Camp | 40 | 2 | 0 | N/A | 20 | 1 | 0 | N/A | 20 | 1 | N/A | N/A |
| Communications | 81 | 4 | 0 | N/A | 20 | 1 | 0 | N/A | 60 | 3 | N/A | N/A |
| Community | 1,188 | 3 | 0 | N/A | 0 | N/A | N/A | N/A | 848 | 1 | N/A | N/A |
| Contaminated Site[(a)] - High and Medium Priority for Action | 401 | 22 | 1 | N/A | 40 | 2 | 0 | N/A | 120 | 6 | N/A | N/A |
| Mine | 9,770 | 6 | 5 | N/A | 7,579 | 5 | 3 | N/A | 9,603 | 5 | 4 | N/A |
| Mineral exploration | 6,925 | 32 | 55 | N/A | 4,189 | 25 | 28 | N/A | 6,121 | 30 | 46 | N/A |
| Portages (winter roads) | 10,938 | N/A | N/A | 409 | 4,530 | N/A | N/A | 171 | 8,194 | N/A | N/A | 300 |
| Staging Area (equipment or material storage) | 20 | 1 | 0 | N/A | 20 | 1 | 0 | N/A | 20 | 1 | N/A | N/A |
| Tourism (e.g., lodges) | 322 | 16 | 0 | N/A | 201 | 10 | 0 | N/A | 242 | 12 | N/A | N/A |
| Transmission Lines | 188 | N/A | N/A | 7 | N/A | N/A | N/A | 0 | N/A | N/A | N/A | 0 |
| **Total disturbance** | **32,480** | **86** | **61** | **516** | **18,753** | **45** | **31** | **255** | **27,676** | **59** | **50** | **397** |

Note: Overlapping areas were merged together so the area was not counted twice.
Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.
a) As defined by the Federal Contaminated Sites Inventory (TBCS 2013).
ha = hectare; km = kilometre; N/A = not applicable.

**Table 12.4-4 Previous and Existing Developments in the Bathurst Herd Effects Study Area for the Base Case (Winter Range)**

| Type of Development | Footprint Area (ha) | Number of Active Sites | Number of Inactive Sites | Linear Feature Length (km) |
|---|---|---|---|---|
| All-Season Road | 1,544 | N/A | N/A | 51 |
| Communications | 39 | 3 | 0 | N/A |
| Community | 1,310 | 3 | 0 | N/A |
| Contaminated Site[(a)] - High and Medium Priority for Action | 401 | 30 | 2 | N/A |
| Highway | 1,078 | N/A | N/A | N/A |
| Fuel Storage | 13 | 1 | 0 | N/A |
| Mine | 2,297 | 1 | 2 | N/A |
| Mineral Exploration | 2,908 | 16 | 21 | N/A |
| Portages | 7,229 | N/A | N/A | 365 |
| Power | 26 | 2 | 0 | N/A |
| Quarrying | 39 | 2 | 1 | N/A |
| Tourism (e.g., lodges) | 155 | 12 | 0 | N/A |
| Transmission Lines | 3,284 | N/A | N/A | 162 |
| Winter Road | 16,105 | N/A | N/A | 824 |
| **Total disturbance** | **36,428** | **70** | **26** | **1,454** |

Note: Overlapping areas were merged together so the area was not counted twice.

Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

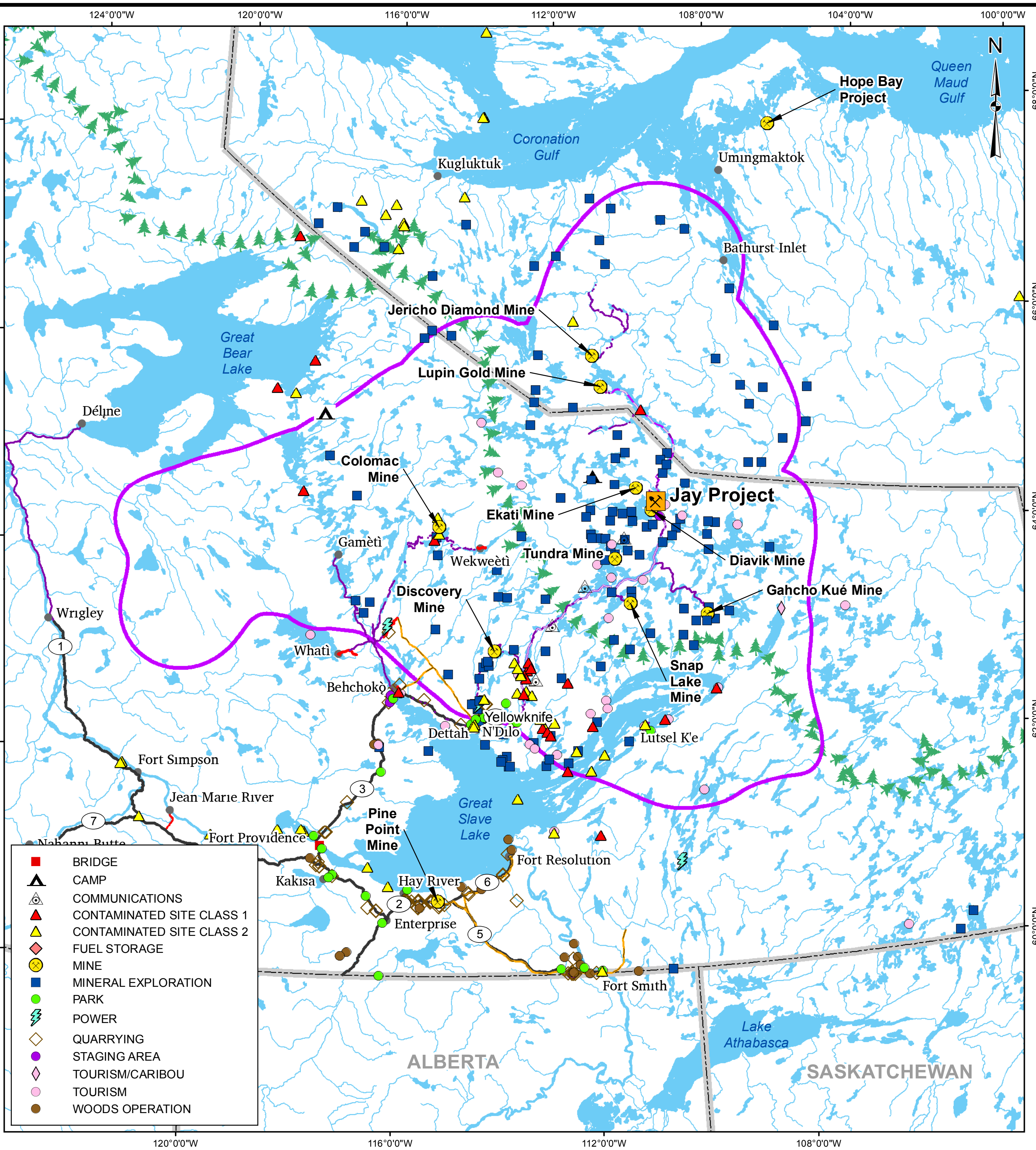
a) As defined by the Federal Contaminated Sites Inventory (TBCS 2013).

ha = hectare; km = kilometre; N/A = not applicable.

### *12.4.1.4 Reasonably Foreseeable Developments*

Cumulative effects assessment should include all other human activities that substantially affect the environment, including past, present, and reasonably foreseeable future projects (MVRB 2004). Although there is uncertainty in predicting which projects proceed to development, it is a necessary exercise to investigate possible future scenarios from a cumulative effects perspective (Section 12.4.1.2).

For the purposes of this assessment, it is assumed that each of the reasonably foreseeable future projects listed below are carried forward to full development, and their effects have spatial and temporal overlap with the Project. The number and type of reasonably foreseeable future developments in the ESA are listed in Map 12.4-2. Note that for projects that have not yet been developed (such as the Izok Corridor Project and Back River Project), locations have been estimated from publicly available information. The reasonably foreseeable developments have been categorized into three tiers, reflecting the level of project information available, their status within the regulatory process, and anticipated development schedule. Descriptions of reasonably foreseeable developments are provided in Section 6.5.2.2.




## LEGEND

- JAY PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TRANSMISSION LINE
- PORTAGE
- TERRITORIAL/ PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- BARREN-GROUND CARIBOU EFFECTS STUDY AREA

150 0 150

SCALE 1:6,000,000 KILOMETRES

## REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

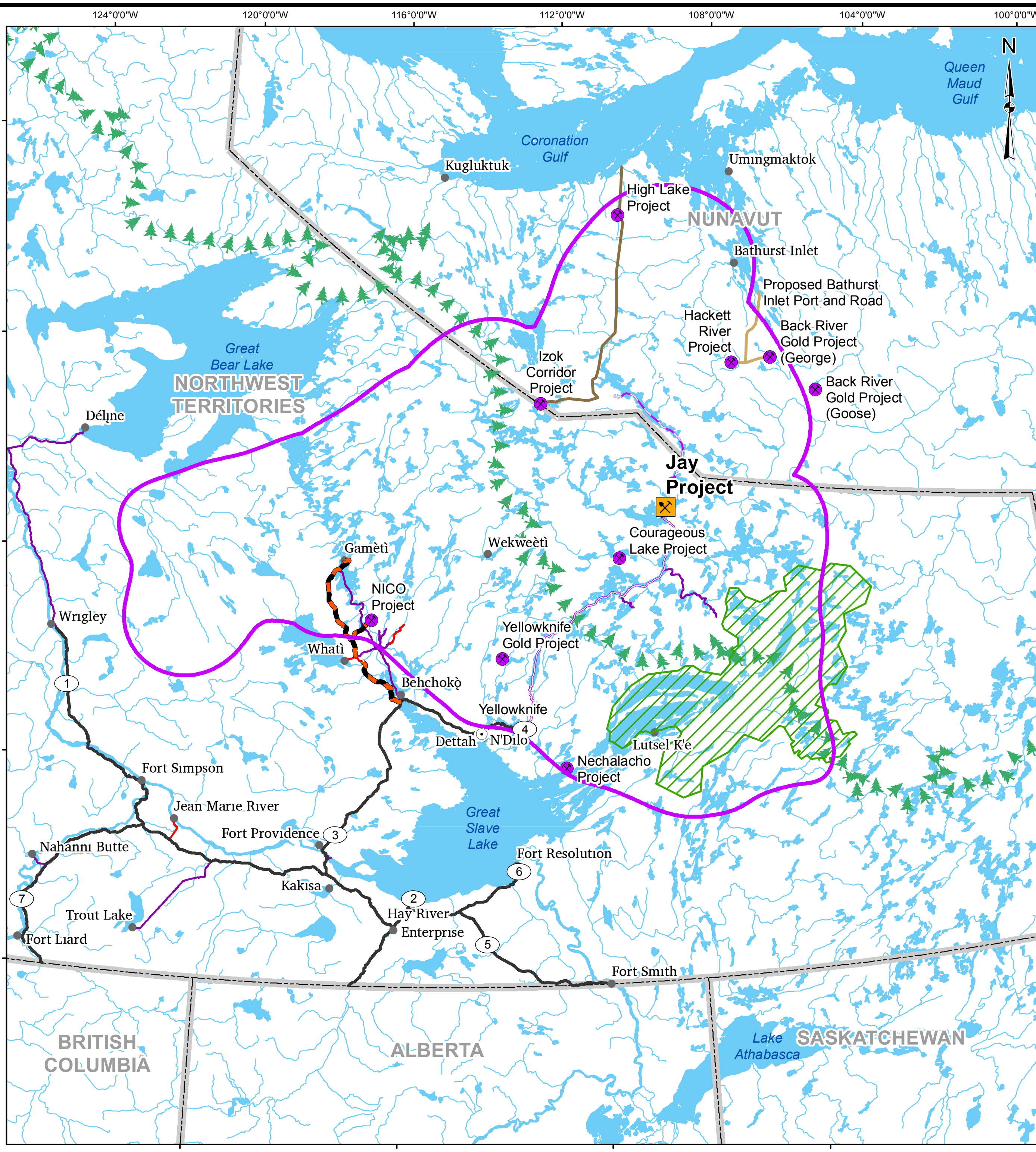
TITLE

**PREVIOUS AND EXISTING DEVELOPMENTS IN THE BARREN-GROUND CARIBOU EFFECTS STUDY AREA FOR THE 2014 BASELINE CONDITION**

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_065_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 02/10/14 | | |
| CHECK | JR | 02/10/14 | **MAP 12.4-1** | |
| REVIEW | LD | 02/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_065_GIS.mxd




## LEGEND

- JAY PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/ PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- REASONABLY FORESEEABLE FUTURE PROJECT
- BATHURST INLET PORT AND ROAD PROJECT
- IZOK CORRIDOR PROJECT
- TŁICHǪ ROAD ROUTE
- THAIDENE NENE (EAST ARM) NATIONAL PARK
- BARREN-GROUND CARIBOU EFFECTS STUDY AREA

150 0 150

SCALE 1:6,000,000 KILOMETRES

## REFERENCE

WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

PROJECT
DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

# REASONABLY FORESEEABLE DEVELOPMENTS IN THE BARREN-GROUND CARIBOU EFFECTS STUDY AREA

Golder Associates

| PROJECT | | 13-1328-0041 | FILE No. DAR_Wild_067_GIS | |
|---|---|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV. 0 |
| GIS | ANK | 02/10/14 | | |
| CHECK | JR | 02/10/14 | MAP 12.4-2 | |
| REVIEW | LD | 02/10/14 | | |

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_067_GIS.mxd

#### *12.4.1.4.1 Assessment Tiers*

### Tier 1 Developments

Tier 1 developments were considered in the Base Case (2014 baseline condition). Environmental assessments for these developments have been completed and the projects are anticipated to be in construction or operation by 2016. The following Tier 1 developments were included in all quantitative analyses (Map 12.4-2):

- The Gahcho Kué Project;
- Nechalacho Rare Earth Elements Project; and,
- NICO Project (including road spur to Whatì).

### Tier 2 Developments

Tier 2 developments were included in the RFD Case. These projects have been formally proposed and details (or the physical footprint) are available, but the anticipated year of construction or operation is uncertain. The following Tier 2 developments were included in all numerical analyses (Map 12.4-2):

- Jericho Mine;
- Hope Bay Project;
- Hackett River Project;
- Back River Project;
- Bathurst Inlet Port and Road (Phase 1 to Back River and Hackett River Projects);
- Izok Corridor Project;
- Lupin Mine;
- Yellowknife Project;
- The Tłįchǫ Road Route (from Highway 3 to Whatì);
- Thaidene Nene (East Arm) National Park;
- Courageous Lake Project; and,
- Indin Lake Project.

### Tier 3 Developments

Tier 3 developments are reasonably foreseeable developments that have not yet been formally proposed, and/or do not have detailed information that is publicly available. These projects were considered in a qualitative assessment of cumulative effects (Section 6.5.2.2). Tier 3 developments include the following:

- Bathurst Inlet Port and Road (Phase 2 to Contwoyto Lake); and,
- Hydroelectric Grid Expansion.

## 12.4.2 Effects on the Abundance and Distribution of Caribou

### *12.4.2.1 Habitat Quantity and Fragmentation*

#### *12.4.2.1.1 Methods*

The incremental and cumulative direct habitat effects from the Project footprint and other previous, existing, and future developments on the Bathurst caribou herd were analyzed through changes in the area and spatial configuration of habitat types on the landscape (i.e., landscape metrics). Landscape metrics for each habitat included total area, number of patches, and mean distance to the nearest patch (mean distance to nearest neighbour [MDNN]) of the same habitat in the seasonal ranges (i.e., ESA). The MDNN is calculated as the shortest straight-line Euclidean distance between the centroids of the closest cells of equivalent habitat patches (McGarigal et al. 2012). Decreases in habitat area and number of similar quality habitat patches can directly influence population size by reducing the carrying capacity of the caribou range. Changes in the number of patches and distance between similar habitat patches can influence the distribution (and abundance) of caribou by affecting the ability of animals to travel across the land.

Delineation of seasons generally followed Johnson et al. (2005); the exception was the date separating winter and spring. Johnson et al. (2005) defined spring as April 15 to June 14, while the analysis completed for the Fortune Minerals Ltd. NICO Project (Fortune 2011) followed the dates set by GNWT-ENR (2013) and considered winter season as November 1 to April 30. In the DAR the GNWT-ENR (2013) dates for winter were adopted, all of April was considered part of winter, and the seasons were defined as follows:

- spring (April 15 to June 14);
- post-calving (June 15 to August 31);
- autumn (September 1 to October 31); and,
- winter (November 1 to April 30).

The incremental and cumulative changes in landscape metrics from the Project and other developments were determined for the Bathurst caribou herd for each season.

The classification of caribou habitat was consistent for spring, post-calving, and autumn ranges, but differed for the winter range. The unique classification for winter habitat was a consequence of two factors. The first was the availability of resource selection function (RSF) coefficients for the four seasons and the data upon which they were based. Previous RSF analyses for the Bathurst caribou herd were completed for spring, post-calving, and autumn ranges but not for winter (Johnson et al. 2004, 2005; Johnson 2009). An RSF analysis was completed for the Bathurst caribou herd winter range for the NICO Project (Fortune 2011). The second factor was the availability of more detailed forest cover in the Earth Observation for Sustainable Development (EOSD) database than in the Canada 250-m Land Cover Time Series data set; a desirable attribute for the winter range below the treeline.

### Spring, Post-Calving, and Autumn Range Land Cover Layers

The quantity of different caribou habitats occurring on the ESA was determined using 2011 land cover data from the Canada 250-m Land Cover Time Series (Version 2), obtained from Natural Resources Canada, and was completed in a Geographic Information System (GIS) platform. The land cover dataset included 25 unique land cover types at a resolution of 250 m. Only 21 of the 25 land cover types occurred within the ESA.

The original land cover types were reclassified into 12 habitat superclasses (hereafter habitats) describing vegetation communities developed by Matthews et al. (2001; Table 12.4-5). Reclassification of the original land cover types was necessary to incorporate information on habitat preferences of the Bathurst caribou herd (Johnson et al. 2004, 2005). Consistency among definitions of the original land cover types provided with the data, definitions of Matthews et al. (2001), visual inspections of the distribution of cover data, and professional opinion guided the reclassification process. A large portion of the unvegetated habitat is comprised of waterbodies (lakes, rivers, and streams). Old burn and young burn habitat superclass designations were crosschecked with Northwest Territories fire data (1965 to 2013) to designate age of burn. For example, shrubland was correlated with recent burn data from 1990 to 2000, and was therefore classed as the young burn superclass (Table 12.4-5). Eskers were identified from the 1:50,000 scale national topographic database, buffered to yield a 250-m corridor width, and merged with the land cover layer.

**Table 12.4-5 Reclassification Matrix of 2011 Land Cover Types to Habitat Superclasses for Spring, Post-Calving, and Autumn Ranges**

| 2011 Land Cover Type | Habitat Superclass |
|---|---|
| Temperate or subpolar needle-leaved coniferous forest, high density | Forest |
| Temperate or subpolar needle-leaved coniferous forest, medium density | Forest |
| Temperate or subpolar needle-leaved coniferous forest, low density | Forest |
| Cold deciduous broad-leaved forest, high density | Forest |
| Cold deciduous broad-leaved forest, medium density | Forest |
| Cold deciduous broad-leaved forest, low to medium density, young regenerating | Old burn |
| Mixed needle-leaved cold deciduous broad-leaved forest, high density | Forest |
| Mixed needle-leaved cold deciduous forest, medium density | Forest |
| Mixed needle-leaved cold deciduous forest, low to medium density, young regeneration | Old burn |
| Shrubland | Young burn |
| Herb-shrub, low vegetation cover | Young burn |
| Taiga, sparse conifer | Forest |
| Shrub-herb-lichen cover | Sedge association |
| Herb-shrub-lichen cover (mesic non-tussock) | Heath tundra/ Heath rock |
| Herb-shrub-lichen cover (barren with lichen and lichen bogs with sedges) | Lichen veneer |
| Wetland, shrub-herb | Riparian shrub |
| Wetland, treed | Peat bog |
| Barren land | Rock association |
| Human disturbance | Unvegetated |
| Water bodies natural and artificial | Unvegetated |

Source: Matthews et al. (2001).

### Winter Range Land Cover Layer

Fortune (2011) determined that 89% of winter locations of the Bathurst caribou herd were found below the treeline and restricted the RSF modelling of winter habitat relationships to the area below the treeline. The DAR also used the winter range below the treeline. For vegetation cover, Fortune (2011) used data from the EOSD. The EOSD data include 23 land cover types at a 25-m resolution (Table 12.4-6), incorporated into a GIS platform. The vegetation data were based on year 2000 coverage, which represents the most accurate source of vegetation data for the EOSD (Wulder 2002). To facilitate habitat modelling and analysis, the 23 land cover types were re-classified into 9 habitat superclasses, and 2 additional superclasses from other data sources were incorporated into the land cover layer (Table 12.4-6).

The reclassification process served to focus the analysis on variables anticipated to most strongly influence habitat selection by caribou. In certain cases, land cover types were combined because the response by caribou was expected to be similar, thereby reducing redundant variables in models (e.g., open and sparse conifer and broadleaf stands). Expected land cover types that caribou may prefer included wetlands (including bryophytes) and coniferous habitat; whereas habitat types that may be avoided include deciduous forest (including mixedwood and broadleaf forest), human disturbances, and recent burns (Bergerud et al. 1984, 2008; Thomas and Kiliaan 1998; Environment Canada 2008; Boulanger et al. 2009; Croft et al. 2009). Water (e.g., frozen lakes and ponds) may be used by caribou for travel and resting while maintaining vigilance for predators. A shrub land cover superclass was included in the analyses because it was hypothesized that shrubland may be avoided owing to low lichen biomass in these habitats (Joly et al. 2010).

Pre-2005 burn data were compiled from available fire polygons for the NWT (Mair 2009) and combined with the EOSD land cover database (Fortune 2011). Polygons defining the spatial extent of more recent fires (2005 to 2013) were delineated using 80% volume contours around Moderate Resolution Imaging Spectroradiometer (MODIS) thermal anomaly data (USDA 2009) within a GIS platform using the Hawth's Tools extension (version 3.27) for ESRI ArcGIS 9.2. Fires from 2014 have not been included in these analyses. Upon joining layers, the 25-m cell layer was resampled to 100-m resolution and the 100-m resolution data then resampled to 200-m resolution. Resampling to a lower resolution was necessary to provide computational efficiency due to the large area of the winter range.

**Table 12.4-6 Land Cover Classes and Associated Re-Classified Superclasses Within the Winter Range of the Bathurst Caribou Herd**

| EOSD Land Cover Class | Re-Classified Habitat Superclass |
|---|---|
| No data | Non-productive / Data deficient[(a)] |
| Cloud | Non-productive / Data deficient[(a)] |
| Shadow | Non-productive / Data deficient[(a)] |
| Snow / ice | Non-productive / Data deficient[(a)] |
| Rock/rubble | Exposed land/rock |
| Exposed land | Exposed land/rock |
| Shrub tall | Shrub |
| Shrub low | Shrub |

**Table 12.4-6 Land Cover Classes and Associated Re-Classified Superclasses Within the Winter Range of the Bathurst Caribou Herd**

| EOSD Land Cover Class | Re-Classified Habitat Superclass |
|---|---|
| Herbs | Shrub |
| Bryoids | Bryoids |
| Wetland – treed | Bog/fen |
| Wetland – herb | Bog/fen |
| Wetland – shrub | Bog/fen |
| Coniferous – dense | Coniferous |
| Coniferous – open | Coniferous |
| Coniferous – sparse | Coniferous |
| Broadleaf – dense | Deciduous |
| Broadleaf – open | Deciduous |
| Broadleaf – sparse | Deciduous |
| Mixedwood – dense | Mixedwood |
| Mixedwood – open | Mixedwood |
| Mixedwood – sparse | Mixedwood |
| Water | Water |
| Not present | Human disturbance[(b)] |
| Not present | Burn[(b)] |

a) Not included in analysis (data make up less than 1% of land cover).
b) Land cover variables obtained from data sources other than EOSD.
EOSD = Earth Observation for Sustainable Development;% = percent.

## Analyses

Spatially explicit datasets describing the location and type of human developments within the seasonal ranges were incorporated into GIS layers. The number and type of previous and existing developments in the ESA of the Bathurst caribou herd are illustrated in Map 12.4-1. Reasonably foreseeable developments in the ESA for the Bathurst caribou herd are illustrated in Map 12.4-2. The resolution of the data layers for land cover and development layers is listed in Table 12.4-7.

**Table 12.4-7 Scales of Data Resolution for Habitat Analyses**

| Season | Land Cover Layer Cell Size (m) | Development Layer Cell Size (m) |
|---|---|---|
| Spring | 250 | 250 |
| Post-calving | 250 | 250 |
| Autumn | 250 | 250 |
| Winter | 200 | 200 |

m = metre.

Landscape metrics were determined using the program FRAGSTATS (Version 4.0) (McGarigal et al. 2012) within a GIS platform. The analysis determined the extent of landscape fragmentation by calculating statistical outputs based on the values of each raster cell. Landscape metrics were determined for reference conditions, 2014 baseline conditions, Application Case, and RFD Case in each seasonal range. The reference condition represents the initial period of Base Case conditions (as far back as data are available). Here, the 2014 baseline condition includes all previous, existing, and approved developments up to 2014 and the Lynx Project.

For the analysis, the proposed Jay Project infrastructure was buffered by 200 m, and the access roads and adjacent pipeline and power line were buffered by 100 m (i.e., 200 m right-of-way) so that a maximum and conservative possible extent of disturbance was used in the assessment of effects on caribou (i.e., the footprint used in the analyses is larger than the actual anticipated Project footprint). The proposed infrastructure that was buffered for the Application Case also includes the expanded WRSA constructed for the Lynx Project (included in Base Case) because it is expected that it will also be used for the Jay Project as an ore stockpile and transfer pad area.

The incremental and cumulative changes from the Project and other developments on the loss and fragmentation of habitat were estimated by calculating the relative difference between the 2014 baseline condition and reference condition, between the Application Case and 2014 baseline condition, and between the RFD Case and the Application Case. The following equations were used to calculate the percent change in the landscape metric for each comparison:

- 100 × (2014 baseline condition value - reference conditions value) / reference conditions value.
- 100 × (Application Case value - 2014 baseline condition value) / 2014 baseline condition value.
- 100 × (RFD Case value - Application Case value) / Application Case value.

The results provide the direction and magnitude of the effect. For example, a high negative value for habitat area would indicate a substantial loss of that habitat type between the two cases.

#### *12.4.2.1.2 Results*

Under reference conditions the spring range was dominated by heath tundra/heath rock (42%), forest (23%), and water habitats (22%) (Table 12.4-8). The reference condition post-calving range had the highest dominance of heath tundra/heath rock (68%), followed by unvegetated (19%) and lichen veneer (6%) (Table 12.4-9). Reference conditions on the autumn range was 53% heath tundra/heath rock, 23% water, and 13% forest (Table 12.4-10). Reference conditions for the winter range was 27% coniferous forest, 24% burn, 22% water, 7% shrub, and 6% exposed land/rock (Table 12.4-11).

**Table 12.4-8 Change (Percent) in Area and Configuration of Habitat Types Within the Bathurst Caribou Herd Spring Range During Reference Condition, Baseline Condition, Application Case, and Reasonably Foreseeable Development Case**

| Habitat | Total Area (ha) | % Change | | | | Number of Patches | % Change | | | | Mean Nearest Neighbour Distance (m) | % Change | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD |
| Lichen Veneer | 733,650 | -0.12 | 0.00 | -0.16 | -0.27 | 12,389 | -0.34 | 0.00 | -0.03 | -0.37 | 951 | 0.14 | 0.00 | 0.03 | 0.21 |
| Water | 4,371,638 | -0.25 | -0.01 | -0.05 | -0.31 | 59,757 | -0.05 | 0.00 | -0.03 | -0.08 | 692 | 0.06 | 0.00 | 0.04 | 0.14 |
| Esker | 136,888 | -0.78 | -0.02 | -0.13 | -0.94 | 2,897 | -0.10 | 0.00 | 0.10 | 0.00 | 1,542 | 0.52 | 0.03 | -0.70 | -0.19 |
| Riparian Shrub | 24,713 | -0.30 | -0.05 | 0.00 | -0.36 | 2,811 | -0.21 | -0.04 | 0.00 | -0.25 | 1,909 | 0.04 | -0.01 | 0.00 | 0.00 |
| Sedge Association | 724,119 | -0.28 | 0.00 | -0.04 | -0.32 | 28,786 | -0.15 | -0.01 | -0.05 | -0.21 | 837 | 0.11 | 0.00 | 0.03 | 0.24 |
| Heath Tundra / Heath Rock | 8,318,456 | -0.26 | -0.01 | -0.16 | -0.43 | 16,521 | 0.32 | 0.00 | 0.05 | 0.37 | 625 | 0.00 | 0.00 | 0.04 | 0.00 |
| Forest | 4,514,175 | -0.27 | 0.00 | -0.11 | -0.38 | 21,936 | 0.10 | 0.00 | 0.02 | 0.11 | 602 | 0.04 | 0.00 | 0.00 | 0.00 |
| Rock Association | 61,906 | -5.38 | 0.00 | -0.11 | -5.48 | 4,104 | -0.78 | 0.00 | 0.00 | -0.78 | 1,671 | -0.10 | 0.00 | 0.02 | -0.12 |
| Peat Bog | 204,819 | -0.24 | 0.00 | -0.02 | -0.27 | 12,980 | -0.15 | 0.00 | 0.01 | -0.14 | 1,082 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old Burn | 48,375 | -0.41 | 0.00 | -0.01 | -0.43 | 1,890 | -0.42 | 0.00 | -0.05 | -0.48 | 1,693 | 0.28 | 0.00 | -0.55 | -0.24 |
| Young Burn | 865,844 | -0.32 | 0.00 | -0.01 | -0.38 | 4,803 | 0.19 | 0.00 | -0.02 | 0.17 | 998 | -0.16 | 0.00 | 0.02 | -0.10 |

Note:% change was measured as the relative incremental change from one time period to the next (e.g., reference to baseline, baseline to application, and application to RFD).
Values of 0.00 represent values greater than, less than or equal to zero, but less than 0.005.
ha = hectare;% = percent; m = metre; RFD = reasonably foreseeable development.

DOMINION DIAMOND

**Table 12.4-9 Change (Percent) in Area and Configuration of Habitat Types within the Bathurst Caribou Herd Post-Calving Range During Reference Condition, Baseline Condition, Application Case, and Reasonably Foreseeable Development Case**

| Habitat | Total Area (ha) | % Change | | | | Number of Patches | % Change | | | | Mean Nearest Neighbour Distance (m) | % Change | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD |
| Lichen Veneer | 530,038 | -0.14 | 0.00 | -0.31 | -0.45 | 10,164 | -0.39 | 0.00 | 0.00 | -0.39 | 922 | 0.18 | 0.00 | 0.06 | 0.33 |
| Water | 1,730,306 | -0.32 | -0.03 | -0.10 | -0.44 | 24,045 | -0.14 | 0.00 | -0.05 | -0.20 | 733 | 0.10 | 0.00 | 0.08 | 0.14 |
| Esker | 72,794 | -1.26 | -0.04 | -0.25 | -1.55 | 1,557 | -0.32 | 0.00 | 0.39 | 0.06 | 1,499 | 1.01 | 0.05 | -0.42 | 0.60 |
| Riparian Shrub | 19,844 | -0.38 | -0.06 | 0.00 | -0.44 | 2,185 | -0.27 | -0.05 | 0.00 | -0.32 | 1,682 | 0.02 | -0.02 | 0.00 | 0.00 |
| Sedge Association | 314,250 | -0.37 | -0.01 | -0.07 | -0.46 | 17,101 | -0.25 | -0.02 | -0.06 | -0.33 | 813 | 0.18 | -0.01 | 0.04 | 0.25 |
| Heath Tundra / Heath Rock | 6,030,963 | -0.30 | -0.01 | -0.23 | -0.54 | 3,561 | 1.21 | 0.00 | 0.36 | 1.57 | 568 | 0.01 | 0.01 | 0.03 | 0.18 |
| Forest | 154,313 | -0.08 | 0.00 | 0.00 | -0.08 | 5,006 | 0.02 | 0.00 | 0.00 | 0.02 | 632 | 0.05 | 0.00 | 0.00 | 0.16 |
| Rock Association | 20,881 | -14.88 | 0.00 | -0.46 | -15.26 | 1,323 | -1.97 | 0.00 | -0.23 | -2.19 | 2,117 | -0.18 | 0.00 | 0.18 | 0.00 |
| Peat Bog | 26,919 | 0.00 | 0.00 | 0.00 | 0.00 | 2,018 | 0.00 | 0.00 | 0.00 | 0.00 | 1,024 | 0.00 | 0.00 | 0.00 | 0.00 |
| Old Burn | 369 | 0.00 | 0.00 | 0.00 | 0.00 | 47 | 0.00 | 0.00 | 0.00 | 0.00 | 5,994 | 0.00 | 0.00 | 0.00 | 0.00 |
| Young Burn | 188 | 0.00 | 0.00 | 0.00 | 0.00 | 22 | 0.00 | 0.00 | 0.00 | 0.00 | 7,728 | 0.00 | 0.00 | 0.00 | 0.00 |

Note:% change was measured as the relative incremental change from one time period to the next (e.g., reference to baseline, baseline to application, and application to RFD). Values of 0.00 represent values greater than, less than, or equal to zero, but less than 0.005.

ha = hectare;% = percent; m = metre; RFD = reasonably foreseeable development.

**Table 12.4-10 Change (Percent) in Area and Configuration of Habitat Types within the Bathurst Caribou Herd Autumn Range During Reference Condition, Baseline Condition, Application Case, and Reasonably Foreseeable Development Case**

| Habitat | Total Area (ha) | % Change | | | | Number of Patches | % Change | | | | Mean Nearest Neighbour Distance (m) | % Change | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD |
| Lichen Veneer | 318,175 | -0.22 | 0.00 | -0.43 | -0.65 | 8,043 | -0.53 | 0.00 | 0.04 | -0.50 | 1,091 | 0.26 | 0.00 | 0.02 | 0.27 |
| Water | 3,204,094 | -0.30 | -0.02 | -0.04 | -0.36 | 42,519 | -0.05 | 0.00 | -0.03 | -0.08 | 686 | 0.06 | 0.00 | 0.03 | 0.15 |
| Esker | 117,488 | -0.91 | -0.03 | -0.10 | -1.04 | 2,568 | -0.12 | 0.00 | 0.12 | 0.00 | 1,458 | 0.61 | 0.03 | 0.02 | 0.62 |
| Riparian Shrub | 22,538 | -0.33 | -0.06 | 0.00 | -0.39 | 2,510 | -0.24 | -0.04 | 0.00 | -0.28 | 1,696 | 0.36 | -0.01 | 0.00 | 0.35 |
| Sedge Association | 571,363 | -0.35 | -0.01 | -0.04 | -0.40 | 27,182 | -0.17 | -0.01 | -0.04 | -0.21 | 820 | 0.12 | 0.00 | 0.02 | 0.24 |
| Heath Tundra / Heath Rock | 7,402,375 | -0.29 | -0.01 | -0.15 | -0.45 | 11,794 | 0.43 | 0.00 | 0.11 | 0.54 | 605 | 0.01 | 0.00 | 0.00 | 0.00 |
| Forest | 1,846,856 | -0.38 | 0.00 | 0.00 | -0.38 | 19,248 | 0.08 | 0.00 | 0.00 | 0.08 | 605 | 0.06 | 0.00 | 0.00 | 0.00 |
| Rock Association | 21,325 | -15.53 | 0.00 | 0.00 | -15.53 | 1,377 | -2.25 | 0.00 | 0.00 | -2.25 | 2,479 | 0.48 | 0.00 | 0.00 | 0.48 |
| Peat Bog | 174,663 | -0.25 | 0.00 | 0.00 | -0.25 | 10,576 | -0.14 | 0.00 | 0.00 | -0.14 | 979 | 0.01 | 0.00 | 0.00 | 0.00 |
| Old Burn | 11,738 | -1.06 | 0.00 | 0.00 | -1.07 | 542 | -0.55 | 0.00 | 0.00 | -0.55 | 2,614 | 0.28 | 0.00 | 0.00 | 0.31 |
| Young Burn | 213,644 | -0.09 | 0.00 | 0.00 | -0.09 | 1,219 | 0.25 | 0.00 | 0.00 | 0.25 | 1,096 | -0.10 | 0.00 | 0.00 | -0.09 |

Note:% change was measured as the relative incremental change from one time period to the next (e.g., reference to baseline, baseline to application, and application to RFD).
Values of 0.00 represent values greater than, less than, or equal to zero, but less than 0.005.
ha = hectare;% = percent; m = metre; RFD = reasonably foreseeable development.

**Table 12.4-11 Change (Percent) in Area and Configuration of Habitat Types within the Bathurst Caribou Herd Winter Range During Reference Condition, Baseline Condition, Application Case, and Reasonably Foreseeable Development Case**

| Habitat | Total Area (ha) | % Change | | | | Number of Patches | % Change | | | | Mean Nearest Neighbour Distance (m) | % Change | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD | Reference | Reference to Baseline | Baseline to Application | Application to RFD | Reference to RFD |
| Exposed Land/Rock | 1,029,164 | -0.63 | 0.00 | -0.04 | -0.67 | 87,361 | -0.12 | 0.00 | -0.03 | -0.15 | 532 | 0.06 | 0.00 | 0.01 | 0.00 |
| Bryoids | 646,288 | -0.06 | 0.00 | 0.00 | -0.07 | 51,646 | -0.13 | 0.00 | -0.01 | -0.13 | 580 | 0.03 | 0.00 | -0.02 | 0.00 |
| Shrub | 1,200,964 | -0.16 | 0.00 | -0.05 | -0.21 | 107,765 | -0.20 | 0.00 | -0.02 | -0.23 | 516 | 0.03 | 0.00 | 0.02 | 0.00 |
| Bog/Fen | 705,380 | -0.24 | 0.00 | -0.06 | -0.31 | 66,638 | -0.35 | 0.00 | -0.04 | -0.39 | 623 | 0.12 | 0.00 | 0.02 | 0.16 |
| Coniferous | 4,343,380 | -0.24 | 0.00 | -0.06 | -0.30 | 64,944 | 0.17 | 0.00 | 0.05 | 0.21 | 459 | 0.02 | 0.00 | 0.00 | 0.00 |
| Broadleaf | 342,088 | -0.33 | 0.00 | 0.00 | -0.33 | 43,362 | -0.25 | 0.00 | 0.00 | -0.25 | 645 | 0.10 | 0.00 | -0.03 | 0.16 |
| Mixedwood | 350,476 | -0.14 | 0.00 | -0.06 | -0.20 | 42,337 | -0.13 | 0.00 | -0.06 | -0.19 | 587 | 0.02 | 0.00 | 0.03 | 0.00 |
| Water | 3,461,832 | -0.58 | 0.00 | 0.10 | -0.48 | 83,011 | 0.08 | 0.00 | -0.03 | 0.05 | 533 | 0.06 | 0.00 | 0.00 | 0.00 |
| Burn | 3,776,528 | -0.29 | 0.00 | 0.00 | -0.29 | 829 | 4.46 | 0.00 | 0.46 | 4.95 | 1,880 | -3.55 | 0.00 | -1.08 | -4.57 |

Note:% change was measured as the relative incremental change from one time period to the next (e.g., reference to baseline, baseline to application, and application to RFD). Values of 0.00 represent values greater than, less than, or equal to zero, but less than 0.005.

ha = hectare;% = percent; m = metre; RFD = reasonably foreseeable development.

In the reference condition, spring, autumn, and winter ranges each had 0.01% of the range classified as disturbance, while there were no disturbances in the post-calving range.

Considering the cumulative changes from reference condition to the 2014 baseline condition, rock association (exposed bedrock or boulder fields; with very little vegetative cover) was reduced by 5% in the spring range, 15% in the post-calving range, and by 16% in the autumn range. Eskers decreased by 0.8%, 1.3%, and 0.9% in spring, post-calving, and autumn ranges, respectively. Exposed rock (-0.6%) and water (-0.6%) were reduced in the 2014 baseline condition for the winter season. In all other habitats, in all seasonal ranges, there was less than a 0.5% decrease in any habitat type between reference condition and 2014 baseline condition. The disturbance footprint increased from reference condition to 2014 baseline condition by approximately 55,000 ha in spring range, 30,000 ha in post-calving range, 46,000 ha in autumn range, and 54,000 in winter range.

The Project footprint covers approximately 1,132 ha, of which 62% is terrestrial habitat and 38% is aquatic habitat (less than 0.01% of the ESA). It is estimated that 4 ha of esker will be disturbed by the Project (Section 11.4.2.2). At closure, the terrestrial area that contains the Project footprint is considered a permanent disturbance on the landscape because the time for vegetation to recover in areas of disturbance is unknown. The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas.

From the 2014 baseline condition to the Application Case with the addition of the Project there was less than 0.1% reduction in area for any habitat in any season. The Project footprint did not intersect with the winter range and there was no change in the winter range disturbance area.

When reasonably foreseeable developments are added to the landscape, all habitats in all seasons show less than 0.5% reduction in area from Application Case to RFD Case. The cumulative direct disturbance from the Project and all previous, existing, and reasonably foreseeable future developments is predicted to be less than 0.6% of the total area in each seasonal range.

The largest absolute number of habitat patches lost from the reference condition to the 2014 baseline condition occurs in the winter range. From 55 (mixedwood) to 230 (bog/fen habitat) patches of habitat have been removed by previous and existing developments. Previous and existing developments increased the number of coniferous (by 109 patches [0.17%]), water (by 70 patches [0.08%]), and burn (by 37 patches [4.46%]) patches in the winter range. The largest relative change in number of patches in the winter range from the reference condition to the 2014 baseline condition occurred in burn habitat (4.46%), followed by bog/fen (-0.35%) and broadleaf (-0.25%) habitats. The number of habitat patches removed by previous and existing developments in the post-calving, spring, and autumn ranges were from 0 to 45 (sedge association habitat, autumn range) patches. The largest negative relative change in the number of patches in the spring, autumn, and post-calving ranges from reference to 2014 baseline conditions occurred in rock association habitat (-0.78% change in spring range, -1.97% change in post-calving range, and -2.25% change in autumn range). The largest positive relative change in the number of patches in the spring, autumn, and post-calving ranges from reference to 2014 baseline conditions occurred in heath tundra/heath rock habitat (0.32% change in spring range, 0.43% change in autumn range, and 1.21% in post-calving range).

The Project is predicted to remove one patch of riparian shrub habitat (0.04% change) and three patches of sedge association habitat (0.01% change) in the spring, post-calving, and autumn ranges, relative to the 2014 baseline condition. The Project is not predicted to remove any habitat patches in the winter range.

The largest absolute decrease in number of patches from the reference condition to the RFD Case occurs in the winter range. From 64 (exposed land/rock) to 257 (bog/fen) patches are predicted to be removed by developments in the winter range. In the winter range, previous, existing, and reasonably foreseeable developments are predicted to increase the number of water (44 patches), burn (41 patches), and coniferous (139 patches) habitat patches, relative to the reference condition. The largest absolute decrease in number of habitat patches in the spring, post-calving, and autumn ranges occurs in sedge association habitat (60 patches removed in spring range). The largest relative decrease in number of habitat patches in the spring, post-calving, and autumn ranges occurs in rock association habitat (2.25% and 2.19% loss in autumn and post-calving ranges, respectively).

The largest absolute increase in the mean distance between nearest neighbour between the reference condition and the 2014 baseline condition occurs in esker habitat in the post-calving range (increase of 15 m), followed by rock association habitat in the autumn range (increase of 12 m). The largest relative increases in mean distance to nearest neighbour from reference to 2014 baseline conditions occurs in esker habitat in the post-calving (increase of 1.01%), autumn (increase of 0.61%), and spring (increase of 0.52%) ranges.

The largest increase in mean distance to nearest neighbour from the 2014 baseline condition to the Application Case occurs in esker habitat in the post-calving range (increase of 1 m [0.05% change]). All other changes to the mean distance to nearest neighbour in the caribou seasonal ranges were less than 1 m between the 2014 baseline condition and the Application Case.

The mean nearest neighbour distance between burn patches is predicted to decrease by 4.6% (decrease of 86 m) in winter between the reference condition and the RFD Case. All other nearest neighbour distances are expected to change by less than 0.8% for any habitat in any season.

Absolute values of each parameter for each assessment case in each season are provided in Appendix 12B (Tables 12B-1 to 12B-4).

#### *12.4.2.2 Habitat Quality, Behaviour, and Movement*

In addition to direct effects from habitat loss and habitat fragmentation, sensory disturbance from the Project and other human development activities (e.g., noise, lights, smells, dust and viewscape) can affect the movement and behaviour of caribou, and reduce effective habitat quality and carrying capacity of seasonal ranges. Local changes in habitat quality from several projects across the seasonal range can negatively affect the population size and distribution of caribou. For example, monitoring data have suggested that caribou groups with calves spend approximately 10% less time feeding within 5 km of the Ekati and Diavik mines (BHP Billiton 2004; Golder 2011a). In another study, blasting was the most likely type of stressor to induce a response, such as running away, for all caribou groups (versus vehicle or human stressors) (Rescan 2007). In addition, Elders are fearful that the caribou will be determined to travel in a particular direction that will lead them to migrate through mine sites. They are worried that in doing so the caribou will be adversely affected by noise and ash (DTC 2001). Changes in time spent feeding and running from disturbance can decrease body condition and affect survival and reproduction.

Evidence suggests that caribou herds respond to diamond mine developments by changing their distribution. The combination of direct (physical footprint) and indirect (sensory disturbances) effects can create a ZOI around developments that change the behaviour and occurrence of caribou. This ZOI appears to be greater than the estimated spatial extent of the independent effects from infrastructure, activities, dust, air emissions, or noise. Johnson and Russell (2014) reported ZOIs of human disturbance on barren-ground caribou that varied with the type of disturbance; ZOIs whose effect distances were not always clearly defined by the data. Recent analyses by Boulanger et al. (2012) found that caribou were four times more likely to occur at distances greater than 11 to 14 km from the Ekati and Diavik mines. A weaker ZOI of 6.5 km was detected for the smaller Snap Lake Mine (Boulanger et al. 2009). Local avoidance of a number of developments can increase density of caribou in non-disturbed areas of the seasonal range and alter migratory movements, foraging conditions, and predation.

### *12.4.2.2.1 Methods*

To estimate the indirect effects of the Project on caribou, habitat values based on RSF models were determined. The RSF values were used to quantify habitat changes between the 2014 baseline condition and reference condition, between the application and 2014 baseline condition, and between the RFD Case and the Application Case. Johnson et al. (2004, 2005) created seasonal range RSF models for barren-ground caribou during the non-winter period. Consequently, analyses during the non-winter period were completed independently for each seasonal range of the Bathurst caribou herd defined by Johnson et al. (2005).

#### Spring, Post-Calving, and Autumn Range Resource Selection Function Values

The approach of Johnson et al. (2004) was used to generate GIS layers of regional-scale RSF values for spring, post-calving, and autumn seasonal ranges. The RSF values were based on the reclassified Canada Land Cover Time Series developed for the caribou habitat quantity and fragmentation analysis (Section 12.4.2.1). Beginning with the 250-m land cover layer from the reclassification of the 2011 land cover dataset, the Region Group raster tool in ArcGIS (V10.1, Redlands, CA) was used to identify patches of habitat of each land cover class. Each patch was a single cell or contiguous group of cells (cells of the same land cover class sharing a border or corner [8 cell connectivity analysis]) separated from other cells of the same land cover type. Patch identification was completed independently for each seasonal range and the area occupied by each patch was calculated. For each patch, the patch weight was calculated as the proportion of the habitat type that the patch represented within each seasonal range:

$$patch\ weight_{ij} = \frac{patch\ area_{ij}}{total\ area_j}$$

where *i* is the individual patch; and,

*j* is the land cover class.

Each 250-m cell within a patch was assigned the weight of the patch to which it belonged and was coded by its land cover class (Johnson et al. 2005). To quantify the RSF value of each cell, seasonal RSF patch coefficients determined for the Bathurst caribou herd (Johnson 2009; Table 12.4-12) were multiplied by the patch weight.

$$cell\ RSF\ value_i = patch\ weight_{ij} \times RSF\ patch\ coefficient_j$$

Cell RSF values were combined into a single comprehensive habitat layer for each seasonal range. Following Johnson et al. (2005), water, rock-dominated, and burned cover were excluded from RSF calculations and the cells coded as nil. Further, cells of habitat superclasses present in spring, post-calving, and autumn seasonal ranges but for which RSF patch coefficients were not applicable (Table 12.4-12) were also coded as nil.

**Table 12.4-12 Seasonal Resource Selection Function Patch Coefficients for Barren-ground Caribou**

| Land Cover | Spring/Calving | | | Post-Calving | | | Autumn | | |
|---|---|---|---|---|---|---|---|---|---|
| | Coef. | Lower 95% CI | Upper 95% CI | Coef. | Lower 95% CI | Upper 95% CI | Coef. | Lower 95% CI | Upper 95% CI |
| Sedge patch | 1.09 | 0.30 | 1.88 | 0.87 | 0.31 | 1.43 | 0.14 | -1.02 | 1.30 |
| Riparian shrub patch | -3.17 | -6.66 | 0.32 | 0.17 | -2.10 | 2.43 | 2.27 | 0.55 | 3.99 |
| Peat bog patch | n/a | n/a | n/a | n/a | n/a | n/a | 0.08 | -3.12 | 3.29 |
| Low shrub patch | -0.07 | -2.08 | 1.94 | -2.73 | -6.45 | 0.99 | n/a | n/a | n/a |
| Heath tundra patch | 1.26 | 0.76 | 1.77 | 1.07 | 0.65 | 1.49 | 0.46 | -0.22 | 1.14 |
| Heath rock patch | 0.99 | 0.40 | 1.58 | 0.98 | 0.50 | 1.46 | 0.98 | 0.27 | 1.70 |
| Rock patch | 1.43 | 0.83 | 2.03 | 0.33 | -0.19 | 0.86 | -0.62 | -2.13 | 0.89 |
| Forest patch | -0.94 | -2.77 | 0.89 | n/a | n/a | n/a | 1.48 | 0.68 | 2.29 |
| Lichen patch | 1.86 | 1.06 | 2.65 | -0.45 | -1.61 | 0.71 | 2.17 | 0.78 | 3.57 |
| Esker patch | -1.30 | -4.41 | 1.81 | 0.14 | -1.83 | 2.11 | -1.02 | -5.71 | 3.66 |
| Old burn patch | n/a | n/a | n/a | n/a | n/a | n/a | 2.44 | 0.06 | 4.83 |
| Unvegetated patch[a] | 1.78 | 0.92 | 2.63 | -0.33 | -1.50 | 0.84 | 2.27 | 0.73 | 3.80 |

Source: Johnson (2009).
a) Composed primarily of open water.
n/a = not applicable;% CI = percent confidence interval; Coef. = coefficient.

## Winter Range Resource Selection Function Values

The RSF models created by Johnson et al. (2004, 2005) did not include an evaluation of habitat value for winter. An RSF for the winter range of the Bathurst caribou herd was developed for the NICO Project (Fortune 2011) and was adopted for the assessment of winter range habitat quality for the Jay Project. For application of the RSF, cover-specific raster grids were generated representing densities of cover at two spatial scales (300 m and 15 km; Fortune 2011). Based on the habitat classes and the RSF coefficients in Table 12.4-12, resource selection values were generated for each 25-m cell across the Bathurst caribou herd winter range. The winter range RSF coefficients (Table 12.4-13) were reapplied to the EOSD data following the updating of the burn layer to 2013 as described in Section 12.4.2.1.1.

For each 25-m cell, the local scale RSF coefficients were applied to the land cover layer that included the updated burn data, while the regional scale RSF values for each 25-m cell were held constant (Fortune 2011). The 25-m cell layer was resampled to 100-m resolution before analyses.

**Table 12.4-13 Resource Selection Function Coefficients for the Bathurst Caribou Winter Range**

| Variable (Super-Class) | Coefficient | Lower 95% CI | Upper 95% CI |
|---|---|---|---|
| **Local-scale[(a)]** | | | |
| Wetland | 8.95 | 5.82 | 12.08 |
| Conifer | 3.36 | 1.12 | 5.60 |
| Deciduous | -18.25 | -23.86 | -12.64 |
| Water | -8.62 | -10.72 | -6.52 |
| Burn | -11.84 | -13.91 | -9.77 |
| **Regional-scale[(b)]** | | | |
| Wetland | -22.48 | -31.59 | -13.37 |
| Conifer | 5.22 | -0.92 | 11.36 |
| Deciduous | -50.79 | -66.93 | -34.66 |
| Water[(c)] | -4.68 | -10.89 | 1.53 |
| Burn[(c)] | 2.79 | -14.85 | 20.43 |

Source: Fortune (2011).

a) Local-scale variables were measured as the relative abundance of a given land cover class within a 300-m radius around a location, expressed on a 0 to 100% scale.

b) Regional scale variables were expressed as the relative abundance of a given land cover class within a 15-km radius around a location, expressed on a 0 to 100% scale.

c) 95% confidence interval (CI) included zero suggesting that variable was potentially uninformative, and could be omitted from habitat mapping.

% CI = percent confidence interval; m = metre; km = kilometre;% = percent.

## Habitat Suitability Categories from Resource Selection Function Values

The RSF values calculated for each seasonal range were used to categorized landscape cells before further analyses (Johnson et al. 2005). For spring, post-calving, and autumn, water was classified as nil before any further analyses were conducted. For presentation purposes, cell RSF values were standardized to a scale of 0.0 to 1.0, independently for each seasonal range, by dividing each cell RSF value by the maximum cell RSF value observed in that seasonal range. The resulting distribution of suitability values was divided as nearly as possible into quartiles representing high, good, low, and poor habitat suitability (following Johnson et al. 2005). Cells within each season were categorized using the following steps:

1) Cells with the same RSF value were placed in the same category.

2) Each cell with an RSF value of 1.0 was classified as having high suitability.

3) Category threshold RSF values were then selected at the points which came closest to achieving the desired results outline in steps 4 to 6 below.

4) As nearly as possible, cells with the lowest 25% of RSF values were placed in the poor category, without violating step 1 or 2.

5) As nearly as possible, cells with RSF values from the 25th to 50th percentile were placed in the low category, without violating step 1 or 2.

6) Any remaining cells without an assigned class and with an RSF value below the 75th percentile were placed in the good category, without violating step 1 or 2.

Because the distribution of standardized patch suitability values for each seasonal range was highly skewed, unique cut-values were required to classify high, good, low, and poor habitat suitability (Table 12.4-14). The standardized patch suitability values do not have any absolute meaning; rather, they express relative values of patches within each season and are not comparable among seasons. High and good quality habitat were considered to be preferred caribou habitat. Seasonal habitat quality analyses were based on layers of cells classified into the four categories.

**Table 12.4-14 Seasonal Patch Quality Standardized Cut Values**

| Habitat Suitability | Spring/Calving | Post-Calving | Autumn | Winter |
|---|---|---|---|---|
| High | 1.000 | 1.0000 | 1.000 | 0.323 to 1.000 |
| Good | 0.371 to 0.999 | NA | NA | 0.233 to 0.322 |
| Low | 0.366 to 0.370 | 0.371 to 0.999 | 0.524 to 0.999 | 0.143 to 0.232 |
| Poor | 0.000 to 0.365 | 0.000 to 0.370 | 0.0 to 0.523 | 0.000 to 0.142 |

NA = not applicable.

## Analyses

Effects of assumed disturbance, which were based on hypothetical (not modelled) disturbance coefficients (DCs) and ZOI, were applied to the RSF values generated from seasonal land cover datasets. Hypothetical DCs provide a surrogate to modelled coefficients and are consistent with previous efforts to estimate effects from development on habitat quality (Johnson et al. 2005; De Beers 2010; Fortune 2011). Disturbance coefficients reduce habitat quality within each defined ZOI. For example, a DC of 0.05 implies that habitat quality was reduced by 95% of the original value.

Several assumptions were made concerning the temporal and spatial extent of effects from the different types of development, particularly with respect to estimating the cumulative effects on caribou. The development layer database does not contain information on the duration of activities associated with land use permits. For example, although the land use permit for mineral exploration may be active for five years, there are no data on the actual frequency and length of time that exploration activities occurred during that period. Subsequently, to estimate the temporal extent of the ZOI from exploration sites, the analysis assumed that approved land use permits were active for five years. The assumption likely overestimates the effect from exploration activities, because exploration typically does not occur throughout the year.

Effects from assumed disturbance were used to quantify changes in the relative availability of different quality habitats during different periods of development for the Base Case (i.e., reference and 2014 baseline conditions), Application Case, and RFD Case. The number of developments and area of the ESA covered by associated zones of influence has changed over time (Figure 12.4-1).

Values of DCs and ZOIs were estimated from the published literature (Johnson et al. 2005; Vistnes and Nellemann 2008; Benítez-López et al. 2010; Boulanger et al. 2012; Table 12.4-15). Noise dispersion modelling for the Project predicted that most noise levels greater than 50 to 55 decibels (construction) and 40 to 45 decibels (operations) should occur within 1 km of the physical footprint (Section 13.4.2.2.1; Appendix 13B; Appendix 13D, Map 13D-1 and Map 13D-2). Correlation among disturbance locations could not be statistically controlled, and therefore, the effects of multiple coefficients at the same location were not multiplied. The coefficient with the strongest effect was applied where zones of influence overlapped, which increased certainty that the predicted effect would not be under estimated for the purpose of this environmental assessment. For example, habitat in the ZOI of the power line along Misery Road (and Jay Road) was assumed to be more affected by the Misery Road (Table 12.4-15) than the power line, which reduced the value of habitat within 250 m of the road to 0, and reduced the value of habitat between 250 m and 1,000 m from the road to 5% of its previous value. As such, the numerical analysis for habitat changes from the additive influence of the power line and Misery Road on caribou used disturbance coefficients for an all-season road, and not the power line because the all-season road coefficients assume more disturbance, which is more conservative. A qualitative analysis is also provided on the separate interactions between roads and caribou, and power lines and caribou.

For closed mines and inactive land use permits, the physical footprint was carried through the entire effects analysis because it was assumed that direct disturbance to the landscape had not yet been reversed. The size of the ZOI was similar for all permitted mines (i.e., 15 km) regardless of the level of activity or size of the development footprint, which would overestimate the effect from the Snap Lake Mine relative to the Ekati and Diavik mines (Golder 2008a, 2011a; Boulanger et al. 2009, 2012).

**Figure 12.4-1 Temporal Changes in the Percentage of the Effects Study Area within Zones of Influence**

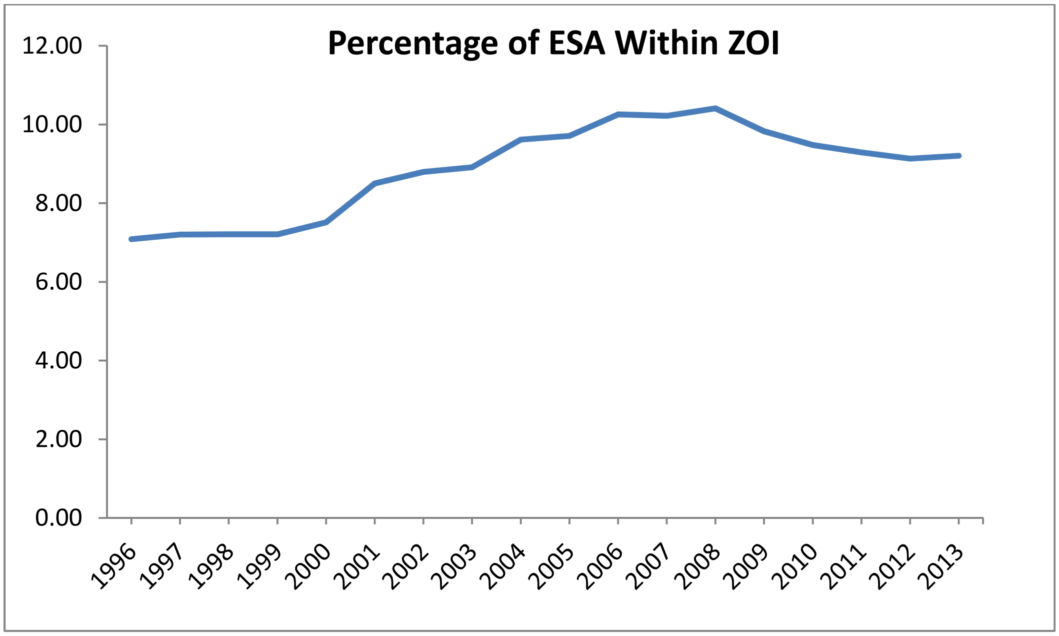


**Table 12.4-15 Extent and Disturbance Coefficients for Development Footprints and Associated Zones of Influence for Caribou Seasonal Resource Selection Functions**

| Disturbance Type | Feature Type | Footprint | | Concentric Zone of Influence #1 | | Concentric Zone of Influence #2 | | Concentric Zone of Influence #3 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Extent (m) | Disturbance Coefficient | Range[a] (km) | Disturbance Coefficient[b] | Range[a] (km) | Disturbance Coefficient[b] | Range[a] (km) | Disturbance Coefficient[b] |
| Campgrounds | Point | 250 | 0.00 | n/a | | n/a | | n/a | |
| Community | Polygon[c] | Actual | 0.00 | 0 to 1 | 0.05 | 1 to 5 | 0.50 | 5 to 15 | 0.75 |
| Communications | Point | 250 | 0.00 | 0 to 1 | 0.90 | n/a | | n/a | |
| Contaminated Site High and Medium Priority for Action[d] | Point | 250 | 0.00 | n/a | | n/a | | n/a | |
| Fuel Storage | Point | 250 | 0.00 | n/a | | n/a | | n/a | |
| Mine | Polygon[c] | Actual | 0.00 | 0 to 1 | 0.05 | 1 to 5 | 0.50 | 5 to 15 | 0.75 |
| Mineral Exploration | Point | 500 | 0.00 | 0 to 1 | 0.50 | 1 to 5 | 0.75 | n/a | |
| Power Plant | Point | 500 | 0.00 | 0 to 1 | 0.50 | n/a | | n/a | |
| Quarrying | Point | 250 | 0.00 | 0 to 5 | 0.75 | n/a | | n/a | |
| Staging Area | Point | 250 | 0.00 | 0 to 5 | 0.75 | n/a | | n/a | |
| Tourism (lodge) | Point | 250 | 0.00 | 0 to 5 | 0.10 | n/a | | n/a | |
| Transmission and Power Lines | Line | 250 | 0.25 | 0 to 1 | 0.50 | 1 to 5 | 0.75 | n/a | |
| All-season Roads and Highways | Line | 250 | 0.00 | 0 to 1 | 0.05 | 1 to 5 | 0.75 | n/a | |
| Winter Road | Line | 250 | 0.00 | 0 to 1 | 0.05 | 1 to 5 | 0.75 | n/a | |
| Winter Road Portage | Line | 250 | 0.00 | n/a | | n/a | | n/a | |
| Miscellaneous (Bridge, Culvert) | Point | 250 | 0.00 | 0 to 1 | 0.90 | n/a | | n/a | |

a) From edge of actual or hypothetical footprint.
b) Disturbance coefficient (applied as a multiplier to cell RSF value), based on assumed disturbance.
c) Footprints were delineated from remote sensing imagery.
d) As defined by the Federal Contaminated Sites Inventory (TBCS 2013).
n/a = Not applicable; km = kilometre; m = metre.

In each seasonal range, for each assessment case, the concentric ZOIs were created and RSF values for cells within each ZOI were multiplied by the appropriate DC. Affected cells were reclassified using the habitat suitability thresholds for that season (Table 12.4-14). For spring, post-calving, and autumn ranges the water layer was reapplied as a nil layer. Relative changes in the area of high, good, low, and poor quality habitat were then calculated for the spring (May 1 to June 14), post-calving (June 15 to August 31), autumn (September 1 to October 31), and winter (November 1 to April 30) seasonal ranges. The following equations were used to calculate the percent change in the amount of different quality habitats for each seasonal range for the different development conditions on the landscape:

- 100 × (2014 baseline condition area - reference condition area) / reference condition area.
- 100 × (Application Case area - 2014 baseline condition area) / 2014 baseline condition area.
- 100 × (RFD Case area - Application Case area) / Application Case area.

#### *12.4.2.2.2 Results*

The amount of habitat in poor, low, good, and high quality categories varied with the seasonal responses of caribou to different land cover attributes (Johnson et al. 2004, 2005). Under reference conditions the approximate amount of preferred habitat (high and good quality habitat) was 39% of the spring range, 66% of the post-calving range, 49% of the autumn range, and 50% of the winter range (Tables 12.4-16 to 12.4-19). The spring range also contained 15% low-quality habitat, 18% poor habitat, and 28% nil habitat. Reference conditions in the post-calving range included 12% poor habitat and 22% nil habitat. Beyond preferred habitat, autumn range reference conditions included 11% low-quality habitat, 16% poor habitat, and 25% nil habitat. The winter range had 25% each of low and poor habitat in reference conditions.

In the 2014 baseline condition, the amount of preferred habitat declined from the reference condition in each seasonal range due to development and associated zones of influence. Decreases in the amount of preferred habitat between reference conditions and 2014 baseline condition were 0.9% of the spring range, 5.3% of the post-calving range, 6.0% of the autumn range, and 5.4% of the winter range. Low-quality habitat decreased in the spring range and increased in each of the other seasons. Poor-quality habitat increased in each seasonal range; 5.0% in spring, 5.4% in post-calving, 5.6% in autumn, and 8.8% in the winter range.

With the application of the Project to the existing landscape, predicted losses of preferred habitat are between 0.0% and 0.2% among the four seasonal ranges. Predicted changes in low-quality habitat are a loss of 0.1% in spring range, and increase of 3.0% in post-calving range, an increase of 0.4% in autumn range, and no change in the winter range. Poor-quality habitat is not expected to change in the winter range from the Project, and is expected to increase by 0.1% in each of the other seasonal ranges.

**Table 12.4-16 Relative Changes in Amount of Different Quality Habitats on the Spring Range of the Bathurst Caribou Herd from Reference Conditions to Application Case**

| Habitat Quality | Reference Condition (ha) | Reference Condition (%) | 2014 Base Case (ha) | Change (%) from Reference to 2014 Base Case | Application Case (ha) | Change (%) from 2014 Base Case to Application Case | Change (%) from Reference to Application Case |
|---|---|---|---|---|---|---|---|
| High | 7,463,463 | 37.3 | 7,089,519 | -5.0 | 7,080,219 | -0.1 | -5.1 |
| Good | 420,038 | 2.1 | 726,725 | 73.0 | 734,681 | 1.1 | 74.9 |
| Low | 3,060,619 | 15.3 | 2,948,481 | -3.7 | 2,946,144 | -0.1 | -3.7 |
| Poor | 3,554,138 | 17.8 | 3,733,531 | 5.0 | 3,737,213 | 0.1 | 5.2 |
| Nil (Water) | 5,508,038 | 27.5 | 5,508,038 | 0.0 | 5,508,038 | 0.0 | 0.0 |
| Total | 20,006,294 | 100.0 | NA | NA | NA | NA | NA |
| **Preferred[(a)]** | **7,883,500** | **39.4** | **7,816,244** | **-0.9** | **7,814,900** | **0.0** | **-0.9** |

a) Preferred habitat = High quality + Good quality.
NA = not applicable,% = percent, ha = hectare.

**Table 12.4-17 Relative Changes in Amount of Different Quality Habitats on the Post-Calving Range of the Bathurst Caribou Herd from Reference Conditions to Application Case**

| Habitat Quality | Reference Condition (ha) | Reference Condition (%) | 2014 Base Case (ha) | Change (%) from Reference to 2014 Base Case | Application Case (ha) | Change (%) from 2014 Base Case to Application Case | Change (%) from Reference to Application Case |
|---|---|---|---|---|---|---|---|
| High | 5,898,563 | 66.3 | 5,584,888 | -5.3 | 5,575,981 | -0.2 | -5.5 |
| Good | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0.0 |
| Low | 0 | 0.0 | 255,225 | NA | 262,825 | 3.0 | NA |
| Poor | 1,081,994 | 12.2 | 1,140,444 | 5.4 | 1,141,750 | 0.1 | 5.5 |
| Nil (Water) | 1,920,306 | 21.6 | 1,920,306 | 0.0 | 1,920,306 | 0.0 | 0.0 |
| Total | 8,900,862 | 100.0 | NA | NA | NA | NA | NA |
| **Preferred[(a)]** | **5,898,563** | **66.3** | **5,584,888** | **-5.3** | **5,575,981** | **-0.2** | **-5.5** |

a) Preferred habitat = High quality + Good quality.
NA = not applicable,% = percent, ha = hectare.

**Table 12.4-18 Relative Changes in Amount of Different Quality Habitats on the Autumn Range of the Bathurst Caribou Herd from Reference Conditions to Application Case**

| Habitat Quality | Reference Condition (ha) | Reference Condition (%) | 2014 Base Case (ha) | Change (%) from Reference to 2014 Base Case | Application Case (ha) | Change (%) from 2014 Base Case to Application Case | Change (%) from Reference to Application Case |
|---|---|---|---|---|---|---|---|
| High | 6,771,713 | 48.7 | 6,363,906 | -6.0 | 6,354,963 | -0.1 | -6.2 |
| Good | 0 | 0 | 0 | 0.0 | 0 | 0.0 | 0.0 |
| Low | 1,485,850 | 10.7 | 1,768,856 | 19.0 | 1,775,756 | 0.4 | 19.5 |
| Poor | 2,214,506 | 15.9 | 2,339,306 | 5.6 | 2,341,350 | 0.1 | 5.7 |
| Nil (Water) | 3,433,356 | 24.7 | 3,433,356 | 0.0 | 3,433,356 | 0.0 | 0.0 |
| Total | 13,905,425 | 100 | NA | NA | NA | NA | NA |
| **Preferred[a]** | **6,771,713** | **48.7** | **6,363,906** | **-6.0** | **6,354,963** | **-0.1** | **-6.1** |

a) Preferred habitat = High quality + Good quality.

NA = not applicable,% = percent, ha = hectare.

**Table 12.4-19 Relative Changes in Amount of Different Quality Habitats on the Winter Range of the Bathurst Caribou Herd from Reference Conditions to Application Case**

| Habitat Quality | Reference Condition (ha) | Reference Condition (%) | 2014 Base Case (ha) | Change (%) from Reference to 2014 Base Case | Application Case (ha) | Change (%) from 2014 Base Case to Application Case | Change (%) from Reference to Application Case |
|---|---|---|---|---|---|---|---|
| High | 3,998,276 | 25.1 | 3,801,183 | -4.9 | 3,801,183 | 0.0 | -4.9 |
| Good | 3,932,512 | 24.6 | 3,704,660 | -5.8 | 3,704,660 | 0.0 | -5.8 |
| Low | 3,968,879 | 24.9 | 4,036,165 | 1.7 | 4,036,165 | 0.0 | 1.7 |
| Poor | 4,058,469 | 25.4 | 4,416,128 | 8.8 | 4,416,128 | 0.0 | 8.8 |
| Nil (Water) | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0.0 |
| Total | 15,958,136 | 100.0 | NA | NA | NA | NA | NA |
| **Preferred[a]** | **7,930,788** | **49.7** | **7,505,843** | **-5.4** | **7,505,843** | **0.0** | **-5.4** |

a) Preferred habitat = High quality + Good quality.

NA = not applicable,% = percent, ha = hectare.

The cumulative changes from human developments on caribou habitat quality from reference conditions through to the RFD Case are presented in Tables 12.4-20 to 12.4-23, and illustrated in Maps 12B-1 to 12B-16 (Appendix 12A). Preferred habitat in the spring range is expected to decline by 1.7%; a combination of a high-quality habitat decline predicted to reach 10.8% and good-quality habitat increase of 160%. The expected change in post-calving habitat is a loss of 13.3% of preferred habitat. The autumn range is expected to lose 12.0% of preferred habitat, and preferred habitat loss in the winter range is expected to be 5.9%.

**Table 12.4-20 Relative Changes in Amount of Different Quality Habitats on the Spring Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case**

| Habitat Quality | Reference Condition (ha) | RFD Case (ha) | Change (%) from Reference to RFD Case |
|---|---|---|---|
| High | 7,463,463 | 6,656,719 | -10.8 |
| Good | 420,038 | 1,093,106 | 160.2 |
| Low | 3,060,619 | 2,886,488 | -5.7 |
| Poor | 3,554,138 | 3,861,944 | 8.7 |
| Nil (Water) | 5,508,038 | 5,508,038 | 0.0 |
| Total | 20,006,294 | NA | 0.0 |
| **Preferred[(a)]** | **7,883,500** | **7,749,825** | **-1.7** |

a) Preferred habitat = High quality + Good quality.

NA = not applicable; RFD = reasonably foreseeable development; ha = hectare;% = percent

**Table 12.4-21 Relative Changes in Amount of Different Quality Habitats on the Post-Calving Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case**

| Habitat Quality | Reference Condition (ha) | RFD Case (ha) | Change (%) from Reference to RFD Case |
|---|---|---|---|
| High | 5,898,563 | 5,112,294 | -13.3 |
| Good | 0 | 0 | 0.0 |
| Low | 0 | 670,394 | NA |
| Poor | 1,081,994 | 1,197,869 | 10.7 |
| Nil (Water) | 1,920,306 | 1,920,306 | 0.0 |
| Total | 8,900,862 | NA | 0.0 |
| **Preferred[(a)]** | **5,898,563** | **5,112,294** | **-13.3** |

a) Preferred habitat = High quality + Good quality.

NA = not applicable; RFD = reasonably foreseeable development; ha = hectare;% = percent

**Table 12.4-22 Relative Changes in Amount of Different Quality Habitats on the Autumn Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case**

| Habitat Quality | Reference Condition (ha) | RFD Case (ha) | Change (%) from Reference to RFD Case |
|---|---|---|---|
| High | 6,771,713 | 5,958,138 | -12.0 |
| Good | 0 | 0 | 0.0 |
| Low | 1,485,850 | 2,061,100 | 38.7 |
| Poor | 2,214,506 | 2,452,831 | 10.8 |
| Nil (Water) | 3,433,356 | 3,433,356 | 0.0 |
| Total | 13,905,425 | NA | 0.0 |
| **Preferred[(a)]** | **6,771,713** | **5,958,138** | **-12.0** |

a) Preferred habitat = High quality + Good quality.

NA = not applicable; RFD = reasonably foreseeable development; ha = hectare;% = percent

**Table 12.4-23 Relative Changes in Amount of Different Quality Habitats on the Winter Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case**

| Habitat Quality | Reference Condition (ha) | RFD Case (ha) | Change (%) from Reference to RFD Case |
|---|---|---|---|
| High | 3,998,276 | 3,756,718 | -6.0 |
| Good | 3,932,512 | 3,704,519 | -5.8 |
| Low | 3,968,879 | 4,059,156 | 2.3 |
| Poor | 4,058,469 | 4,437,743 | 9.3 |
| Nil (Water) | 0 | 0 | 0.0 |
| Total | 15,958,136 | NA | 0.0 |
| **Preferred[(a)]** | **7,930,788** | **7,461,237** | **-5.9** |

a) Preferred habitat = High quality + Good quality.

NA = not applicable; RFD = reasonably foreseeable development; ha = hectare;% = percent

Regulators and local communities have concerns that increased traffic on the Misery Road may act as a barrier to caribou movement. The initial response of caribou to roads is avoidance, although in time caribou may become habituated to the presence of roads and traffic (Haskell and Ballard 2008; ERM Rescan 2014a,b; Johnson and Russell 2014). From 2011 to 2012, motion detection wildlife cameras were used to investigate caribou interactions with the Misery Road and other mine site roads (ERM Rescan 2014a). The overall rate of deflections was observed at approximately 2% of road interactions, meaning that 98% of the caribou-road interactions photographed did not show clear observations to suggest that the Misery Road impeded movement. Deflections did not appear to be affected by changing traffic levels on the Misery Road over the duration of the study (ERM Rescan 2014a). However, the effective range of the cameras is likely limited to less than 500 m, meaning that caribou reactions to the road beyond this distance would be difficult to discern from the data.

Traffic volumes on the Misery and Jay roads are anticipated to be 56 trips per day by road trains. A road train consists of one truck pulling three trailers. There are expected to be seven road trains making eight trips per day) (Section3.5.1.6). There will be approximately 12.3 minutes between each road train. Modified traffic patterns and road closures will be used as necessary to mitigate barrier effects to caribou.

Regulators and local communities have also expressed concern about effects on caribou movement and distribution from the above-ground power line that will be constructed along the Misery Road. It is believed that reindeer perceive ultraviolet light (Hogg et al. 2014), and may see a power line as a long string of randomly flickering light when it is dark (Tyler et al. 2014). Specific research into the influence of power lines on caribou movements and distribution is limited (particularly for barren-ground caribou), and has primarily focused on transmission lines.

Dominion Diamond is proposing to develop a distribution line, which has a smaller footprint and wire size, and carries less voltage than a transmission line. Transmission lines carry 115 kilovolts (kV) or higher to load centres, while distribution lines carry lower loads of electricity (1 to 69 kV) from the load centre to customers (APLIC 2012). Most studies looking at the effects of distribution lines on caribou/reindeer have occurred in Norway and have been completed for reindeer. In addition, power lines in woodland areas also include a right-of-way cutline through forest, which also affects caribou distribution (Dyer et al. 2002), and is not applicable to the Misery power line.

Berger et al. (2000) concluded that the predicted avoidance of a 66-kV power line by woodland caribou could not be easily confirmed. The study found that reduced use of habitats near linear features by woodland caribou was greatest near roads, and the power line had the least effect (Berger et al. 2000). Berger et al. (2000) found that natural linear features, such as river valleys, had a stronger influence than the power line.

Vistnes and Nellemann (2001) reported that the mean density of semi-domesticated reindeer was 73% lower in areas less than 4 km from a 66-kV distribution line (without traffic) compared to areas greater than 4 km from the distribution line, and within similar terrain. In a related study, Vistnes et al. (2001) found that density of reindeer in quadrants of 2x2 km was reduced by approximately 50% when the density of power lines greater than 66 kV exceeded 0.5 kilometres per square kilometre (km/km$^2$), and by 98% in areas where ski trail density exceeded the same threshold. More recently, reindeer were found to exhibit stronger avoidance of disturbances with human traffic than infrastructure without traffic (Vistnes et al. 2008). Specifically, reindeer avoided disturbances associated with human activity such as tourist trails, resorts, and major roads, but did not avoid areas with low human activity levels, which included power lines, minor roads, and closed roads.

A study to document wild reindeer responses to a 66-kV distribution line, using both aerial surveys and evidence of lichen grazing in an alpine area was completed in Norway (Reimers et al. 2007). The study found evidence of reindeer grazing beneath and crossing the power line in 14 of the 22 years, and grazing patterns did not appear to be correlated to the distribution line. The authors concluded that the distribution line was not creating a barrier or causing reindeer avoidance. In a previous study, Reimers et al. (2000) concluded that the data available indicate that reindeer habituate to distribution lines shortly after their construction, when the distribution lines are not accompanied by other human activity (such as roads).

Power lines may also create an audible hum (corona noise), which increases as the conductor approaches maximum load (Reimers et al. 2000; Flydal et al. 2003). This hum is separate from noise created from wind action on the power line and poles. Reindeer can hear corona noise (Flydal et al. 2003); however, measurements were made on transmission lines (300 and 420 kV) and not distribution lines, such as the 69-kV distribution line along the Misery and Jay roads. Flydal et al. (2003) indicated that the hearing ability of humans is better than that of reindeer, except at the highest frequencies. Therefore, continuous noise may have a weaker effect on caribou than unpredictable noise (e.g., noise from blasting, vehicles, aircraft), which caribou may associate with danger (Flydal et al. 2003, 2009).

A power line with a load of 1 to 5 megawatts (MW) has an audible noise of 24.5 to 24.6 decibels (approximately as loud as a whisper) at 1.5 m elevation from the ground (Harper 2014). For comparison, this level is roughly equivalent to natural background noise levels measured near the Ekati Mine. The anticipated load on the Misery (and Jay) power line is expected to be 1 to 3 MW (Harper 2014) and so corona noise from the power line is not expected to be audible under most conditions.

The information presented above suggests that above-ground distribution lines have smaller effects on caribou than roads with traffic. As such, it is predicted that the power line along the Misery Road (and Jay Road) will have little effect on caribou movements and distribution. If caribou movements and distribution change during the construction and operation of the Project, it is more likely that these changes will be due to the increased traffic volume on the roads. Mitigation and adaptive management using the results from monitoring are anticipated to limit the effects on caribou movements and distribution from the Misery and Jay roads.

### *12.4.2.3 Behaviour, Energy Balance, and Calf Production*

#### *12.4.2.3.1 Methods*

Reduced rates of calf survival and female fecundity (i.e., parturition or calf production) have been cited as key factors contributing to recent declines in the Bathurst herd (Boulanger et al. 2011). Several natural large-scale environmental factors can influence the survival and reproduction of caribou through changes in behaviour, foraging, and energetics (protein and energy balance). Food abundance and quality on summer and winter ranges have been determined to be important elements in the population dynamics of tundra caribou (Reimers 1983; Skogland 1990; Post and Klein 1999). Snow conditions, such as depth and hardness, also affect the movement rate and food accessibility for caribou (Stuart-Smith et al. 1997).

Inuit who have participated in the Caribou and Roads Workshops have identified climate change as an additional factor putting pressure on the caribou (Section 12.2.3.7). The increased occurrence of freezing rain in the winter, for example, makes it more difficult for caribou to forage through the snow and can result in poor calving success. From 1950 to 1955, Inuit noticed a decline in some herds as a result of freezing rain conditions (Banci et al. 2007).

Factors that influence adult female food intake and energetics from post-calving through winter also determine pregnancy and calving rates. In addition, extreme weather events such as late spring snowfall or late snowmelt can influence access to food and result in lower calf weights or delayed parturition (time of calving), which influences survival of young (Skogland 1984; Adamczewski et al. 1987; Cameron et al. 1993). High insect abundance can also decrease forage intake, milk production, and calf growth and possibly survival (Helle and Tarvainen 1984; Russell et al. 1993; Hagemoen and Reimers 2002; Weladji et al. 2003).

A complex interaction between habitat, and caribou foraging and movement patterns also exists, but it is not well understood for barren-ground caribou herds. For example, studies of caribou have shown that the historical cumulative effect of overgrazing on calving, summer or winter ranges can result in periodic range shifts and large population fluctuations (Messier et al. 1988; Ferguson and Messier 2000). Traditional knowledge also contends that fire frequency and intensity affects caribou numbers and distribution (Kendrick et al. 2005). Tłįchǫ Elders state that caribou use their sense of smell to locate the best vegetation in any given year (WKSS 2001a,b). As such, recent burns may be avoided by caribou because they cannot smell food, just burnt vegetation (WKSS 2001a) (Section 12.2.3).

Loss of body weight in adult females due to interactions with ZOIs from development on the landscape also may result in reduced calf production, poor winter condition, and increases in the likelihood of predation. During the post-calving to autumn/rut periods, animals have the greatest potential for travelling through or encountering a number of developments on the landscape (Boulanger et al. 2004). In addition, these seasons or life stages have been identified as critical periods for foraging when animals must achieve satisfactory body weight and condition to increase the chance of becoming pregnant and producing a calf the following spring (Cameron and Ver Hoef 1994; Gerhart et al. 1997; Bradshaw et al. 1998; Cameron et al. 2005). While energy-protein models have been created for some caribou herds (e.g., Porcupine herd), the partitioning of protein and energy from food into body mass gains and losses is a complicated process, and sensitivity analyses of key model components have not been published (White et al. 2013). Such a model is not available for general use, its inputs and outputs are not readily interpretable, and it requires extensive herd-specific datasets (Russell 2014).

The objective in this section is to assess the energy implications of cumulative encounters with developments and insect harassment during the post-calving and fall/rut seasons on autumn body weight in female caribou, and ultimately, on the fecundity of individuals in the Bathurst herd. Fecundity is defined as the likelihood of a female becoming pregnant in autumn and successfully producing a calf in the spring. Although other factors can influence the body condition of caribou, such as food quality and accessibility on summer and winter ranges, effects related to human development and insect harassment are examined because they are commonly discussed as contributing factors to the recent population decline. Furthermore, data for zones of influence from mining activities and insect harassment indices are more available relative to the quality of food on seasonal ranges.

Information from satellite-collared caribou was used to quantify residency and encounter rates of female caribou with zones of influence from development (1996 to 2013). The analysis focused on satellite locations starting from June 15 (post-calving range) though October 31 (autumn range). A simple model was constructed to estimate the energy cost from a single encounter with disturbance caused by development activities using information in previously published literature (Bradshaw et al. 1998). The energy cost was a function of the associated reduction in protein and fat (energy) content from loss of body weight due to interactions with development. An insect harassment index (IHI) was used to predict the energetic cost to female caribou and subsequent reduced fecundity for different levels of insect activity. The results were used to make inferences about the effects from disturbance associated with development and insects on caribou reproduction and population size (Gunn et al. 2001).

## Zone of Influence Residency and Encounters

The West Kitikmeot Slave Study Partners identified caribou movement routes and calving ground protection as research priorities in 1995. Since 1996, satellite telemetry has been used to describe movements of Bathurst collared caribou across their annual range. Initially 10 transmitting collars were deployed in 1996, after which time the number of collars has varied among years. In general, the caribou satellite data were based on a duty cycle that varied from every 7 to 10 days to every 1 day, and became more frequent during more recent years (Table 12.4-24).

Starting in 2002, transmitters were also programmed to transmit at 1-day intervals from July 1 to August 15 to better describe post-calving movements. In 2009, the frequency of locations was increased to approximately every three hours during the summer to autumn period. When multiple locations were obtained for an individual caribou during a single day, the best location each day was used as classified by on-board collar software. Satellite data examined here have been shown in annual reports from industry and government agencies (e.g., Gunn et al. 2001; Golder 2003; Boulanger et al. 2004; Johnson et al. 2004, 2005; DDMI 2008; Golder 2014d).

**Table 12.4-24 Summary of Collared Caribou, Location Interval, and the Number of Linear Segments (Euclidean Path Lines Between Successive Locations) for Female Bathurst Caribou (1996 to 2013)**

| Year | Number of Collared Animals | Mean Days Between Locations | Mean Number of Segments or Partial Paths per Animal |
|---|---|---|---|
| 1996 | 10 | 6.5 (3.5-27.5) | 28.1 (4-32) |
| 1997 | 7 | 4.2 (4.1-4.2) | 31.9 (31-32) |
| 1998 | 20 | 9.6 (4.2-27.5) | 7.0 (1-32) |
| 1999 | 14 | 5.9 (4.2-9.2) | 23.3 (6-32) |
| 2000 | 13 | 5.6 (4.2-10.8) | 23.5 (8-32) |
| 2001 | 13 | 5.7 (5.0-9.4) | 20.9 (6-27) |
| 2002 | 11 | 3.5 (1.2-5.1) | 41.3 (26-64) |
| 2003 | 11 | 3.0 (1.8-6.8) | 50.3 (4-65) |
| 2004 | 15 | 5.0 (1.6-21.0) | 19.5 (2-56) |
| 2005 | 19 | 2.4 (2.1-5.1) | 58.2 (1-64) |
| 2006 | 15 | 2.2 (1.3-2.9) | 58.7 (34-64) |
| 2007 | 19 | 1.9 (1.4-2.7) | 68.8 (30-88) |

**Table 12.4-24 Summary of Collared Caribou, Location Interval, and the Number of Linear Segments (Euclidean Path Lines Between Successive Locations) for Female Bathurst Caribou (1996 to 2013)**

| Year | Number of Collared Animals | Mean Days Between Locations | Mean Number of Segments or Partial Paths per Animal |
|---|---|---|---|
| 2008 | 14 | 1.9 (1.4-2.7) | 63.0 (14-89) |
| 2009 | 13 | 0.5 (0.2-1.5) | 393 (89-465) |
| 2010 | 19 | 0.4 (0.2-1.6 | 331 (16-467) |
| 2011 | 18 | 0.4 (0.2-1.0) | 296 (77-455) |
| 2012 | 22 | 0.4 (0.2-1.1) | 346 (63-514) |
| 2013 | 13 | 0.5 (0.2-1.9) | 359 (63-513) |

Note: Numbers in parentheses = minimum to maximum values.

Within a GIS platform, movement paths were created per animal and year by joining sequences of successive locations. Because the frequency of satellite collar locations has increased during the last eight years, the number of segments (distance intervals or partial paths) between successive locations for each animal has also increased (Table 12.4-24). The analysis was restricted to the Bathurst herd, and for the combined post-calving and autumn (or rut) seasons (June 15 to October 31 [138 days]). The movement vectors were then combined with the development layer database that was used for the habitat analyses (Section 12.4.2.1).

The analysis was executed each year of the study so that a caribou path would only have the potential to intersect the ZOIs from developments that were determined to be present during a given year (e.g., active mine sites and exploration permits) from 1996 to 2013 (i.e., Base Case). In addition, movement paths from 1996 to 2013 were used to forecast encounter rate and residency time for future projects not currently on the landscape for the Application Case (i.e., the Jay Project, and approved developments [Lynx and Gahcho Kué projects]), and the RFD Case (Section 12.4.1.2).

The analysis was used to calculate the residency time of female caribou in ZOI, and the encounter rates with ZOI. Specifically, the percentage of days that caribou resided within ZOIs (i.e., residency time) of the total possible days during the exposure period (i.e., 138 days) was calculated for each individual female movement path. It was assumed that for each day in a ZOI, an animal was exposed to one disturbance event, regardless of how close it was to a development footprint or activity. To complement residency times, the number of animal encounters with ZOI during the exposure period was also calculated for each female movement path. It was assumed that each time an animal entered a ZOI, the animal was exposed to one disturbance event (also independent of distance to disturbance). This is a conservative approach in that the ZOI would be expected to have a gradient-effect with diminishing effect further from the source.

Because some of the paths did not extend for the duration of the exposure period (i.e., on average, 113 of 138 possible coverage days), total encounters for incomplete paths were standardized to encounters per 138 days. For the assessment of encounter rates and energetics, data from 1996 to 2013 were describing previous and existing baseline conditions (i.e., Base Case) prior to the Application Case. At the time of the analysis for the DAR, this was the most recent year that contained complete information on the movements of satellite-collared animals during the summer to autumn period.

## Energetics Model

### *Sensory Disturbance*

The encounter rates with ZOI and associated major sensory disturbance events (hereafter referred to as a disturbance event) on individual female caribou were used to estimate the change in caribou energetics and subsequent effects on fecundity (i.e., parturition rate). The hypothesis is that industrial developments affect parturition rates by creating sensory disturbances that alter caribou behaviour and energetics as they migrate from calving areas to the winter range (before the onset of freeze-up and unfavourable winter conditions) (Bergerud et al. 1984; Cameron et al. 2005). For example, an animal near an active mine may encounter and respond to noise or visual disturbances (viewscape) from a human walking or working outside, a moving vehicle, blasting, and/or a plane flying overhead. Based on data collected at the Ekati Mine from 2001 through 2008, the fraction of caribou groups that showed a behavioural response to sensory disturbances was 55% (Rescan 2010).

The energetic model quantified costs for an encounter (i.e., a single sensory disturbance event), calculated as the sum of energetic costs (megajoules [MJ]) for the initial flight response, additional movements, plus the cost of excitement. Most of the analysis is based on an energy model for adult female caribou of the Denali Herd in Alaska (Boertje 1985). It was assumed that this model was applicable to caribou of the Bathurst herd.

Bradshaw et al. (1998) noted that disturbed caribou in the boreal forest of Alberta move rapidly from the source for approximately 15 minutes. It was assumed herein that, when animals exhibit a behavioural response, they are running away or trotting. This is an ecologically conservative assumption because responses can vary and be as negligible as only looking in the direction of the disturbance (Rescan 2009). Based on a trotting and galloping cost of 0.035 megajoules per kilogram per hour (MJ/kg/h) for 0.25 hours, the cost of the initial flight response was calculated to be 0.88 MJ (assuming an average-sized female of 100 kilograms (kg) body weight (Cameron and Ver Hoef 1994; Adamczewski et al. 2009). ERM Rescan (2014b) determined that the duration of disturbed behaviour by caribou following a disturbance event is less than one minute, so the 0.25-hour duration assumed in the energetic model is conservative. Next, it was determined that caribou travelled, on average, an additional 2.11 km after a disturbance event (Bradshaw et al. 1998). The cost of this extra distance was calculated as walking cost x body weight x distance travelled. Assuming that barren-ground caribou require 0.00264 megajoules per kilogram per kilometre (MJ/kg/km) for walking (Boertje 1985), an average-sized female caribou expends an additional 0.56 MJ of energy when disturbed.

Local and traditional knowledge identified the Narrows as a critical caribou migration route (Section 12.2.3). For a migratory caribou population like the Bathurst herd, the encounter with a disturbance in their movement path may have the added cost of being deflected around the disturbance. Roads have been described as a semi-permeable barrier for caribou movements (Dyer et al. 2002). For the purpose of this assessment, traffic along the Misery and Jay roads was expected to be seven road trains (one truck pulling three trailers), which will complete eight trips per day (i.e., 56 trips per day; Section 3.5.1.6). For these analyses, it was conservatively assumed that caribou would not cross the Misery and Jay roads as a consequence of increased traffic, and would be deflected by the Jay Pit and not cross the Narrows. Therefore the interaction with these roads and the Project would result in movement of caribou around the Ekati Mine that would increase energetic cost. This is a conservative approach in that monitoring data at the Ekati Mine illustrates that vehicle traffic on the Misery Road does not create a complete barrier to caribou movement (Section 12.2.2.2). The implementation of modified traffic patterns and road closures is also expected to limit the effect of increased traffic from the Jay Project on caribou movement through the Ekati Mine area. To determine the energetic cost of a deflection movement, two hypothetical routes that avoided the Project, Misery Road, and the Ekati or Diavik mine infrastructure were assumed and compared to seven alternate caribou paths determined by Traditional Knowledge (DTC 2001; Map 12.4-3).

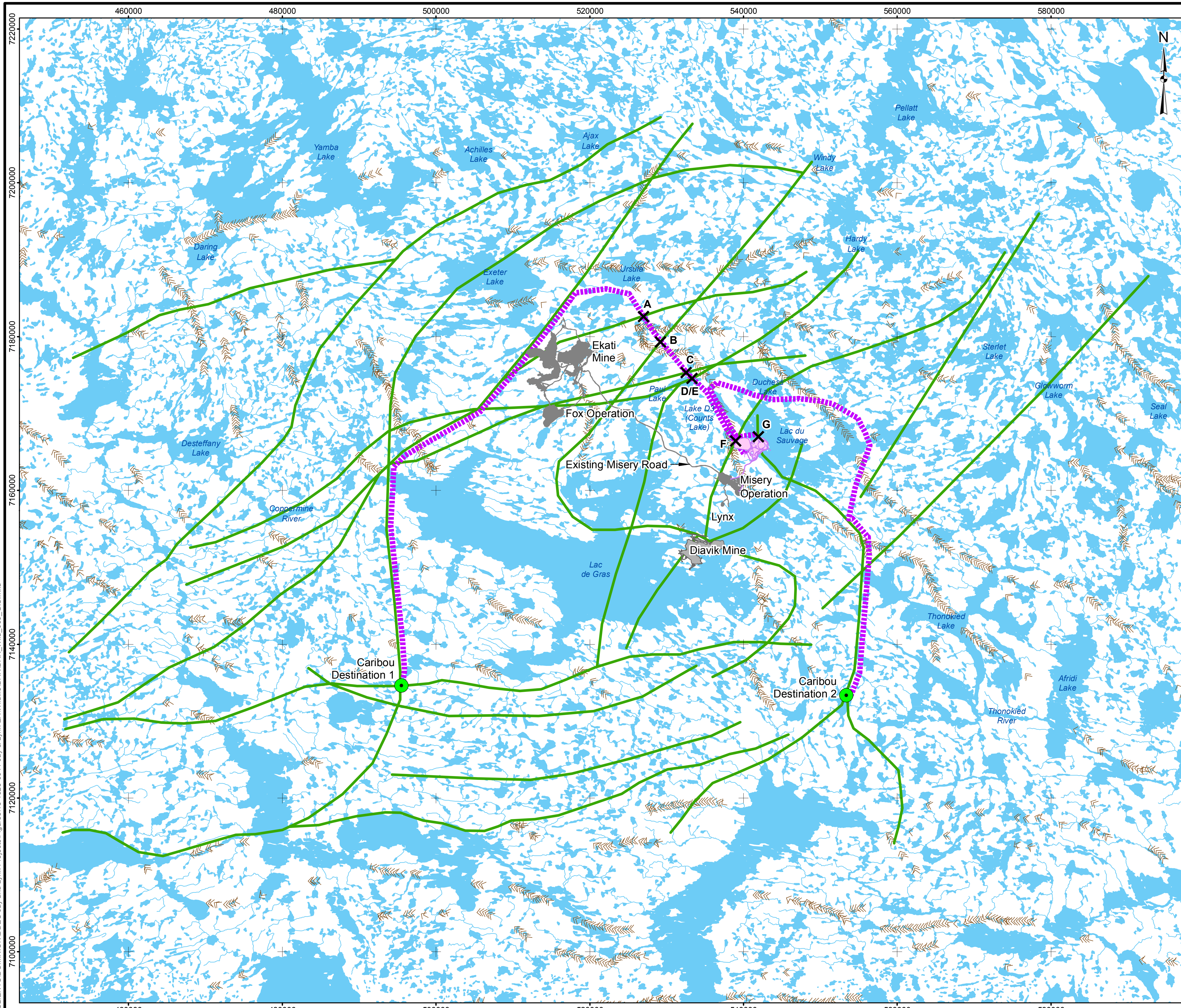
Six of seven alternate paths identified from Traditional Knowledge exhibited a northeast-southwest orientation, and one path a northwest-southeast orientation. The northwest-southeast orientated path crossed the Narrows. A net deflection distance was determined for each alternate path assuming hypothetical deflection points that intersected with Traditional Knowledge paths and common caribou destinations (Table 12.4-25). The maximum additional distance for a deflection movement around the Project, Misery and Jay haul roads, and Ekati and Diavik mine infrastructure was 29.6 km. This distance was applied to the cost for each disturbance event, which increased the loss of body mass for each encounter across females in the population (2.11 km + [29.6 km / maximum mean annual encounters] = 2.11 km + 1.56 km = 3.67 km) (see Section 12.4.2.3.2 for encounter rates). Adjusting for a Bathurst herd adult female body mass of 100 kg and a required movement of 3.67 km yields an average movement cost of 0.97 megajoules per day (MJ/day).

**Table 12.4-25 Distances of Traditional Knowledge-Based Caribou Paths and Deflection Paths**

| TK Path | Path Destination | TK Path Distance (km) | Deflection Distance (km) | Net Difference (km) |
|---|---|---|---|---|
| A | 1 | 118 | 76.6 | -41.4 |
| B | 1 | 67.8 | 72.5 | 4.7 |
| C | 1 | 70.4 | 82.5 | 12.1 |
| D | 1 | 66.6 | 82.5 | 15.9 |
| E | 1 | 69.1 | 82 | 12.9 |
| F | 1 | 63.2 | 92.8 | 29.6 |
| G | 2 | 40.6 | 67.6 | 27.0 |

Net Difference (km) = Deflection Distance (km) - TK Path Distance (km).

TK = Traditional Knowledge; km = kilometre.




## LEGEND

- EKATI MINE FOOTPRINT
- DIAVIK MINE FOOTPRINT
- PROPOSED JAY FOOTPRINT
- ESKER
- WATERCOURSE
- WATERBODY
- CARIBOU DESTINATION
- CARIBOU PATH DEFLECTION POINT
- CARIBOU DEFLECTION PATH
- TRADITIONAL KNOWLEDGE CARIBOU PATH

## REFERENCE

NATIONAL TOPOGRAPHIC BASE DATA (NTDB) 1:250,000
CANVEC © NATURAL RESOURCES CANADA, 2012
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
DATUM: NAD83 PROJECTION: UTM ZONE 12N

## DOCUMENT

DEVELOPER'S ASSESSMENT REPORT

10 0 10
SCALE 1:500,000 KILOMETRES

PROJECT
DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE
# TRADITIONAL KNOWLEDGE BASED CARIBOU PATHS AND PROJECT-RELATED DEFLECTION PATHS IN THE LAC DE GRAS AREA

Golder Associates

| PROJECT | 13-1328-0041 | FILE No. DAR_Wild_069_GIS |
|---|---|---|
| DESIGN | LD | 15/07/14 | SCALE AS SHOWN | REV 0 |
| GIS | ANK | 01/10/14 |
| CHECK | JR | 01/10/14 |
| REVIEW | LD | 01/10/14 |

MAP 12.4-3

G:\CLIENTS\DOMINION\DDEC Jay and Lynx Projects\Figures\13-1328-0041 Jay & Lynx EA\Wildlife\DAR\DAR_Wild_069_GIS.mxd

An increase in metabolic rates can also result from prolonged excitement from a disturbance event (MacArthur et al. 1979). Nervousness and increased muscular tension can account for a 10% increase in metabolic costs above maintenance requirements (Blaxter 1962). It was assumed that animals are excited for a 12-hour period following a sensory disturbance event, even though prolonged excitement may not extend for that time period (Boertje 1985). Based on a daily fasting metabolic rate (FMR) of 0.403 MJ/kg$^{0.75}$ (McEwan 1970; Bradshaw et al. 1998), the incremental cost of excitement above maintenance requirements was calculated as 0.10 x (100 kg)$^{0.75}$ x FMR x 0.5 days = 0.64 MJ. Thus, total cost of disturbance is approximately 2.48 MJ (0.97 MJ for walking + 0.88 MJ for flight response + 0.64 MJ for prolonged excitement).

To determine the energy equivalent of body weight of caribou, endogenous reserves were divided into two categories: loss by fat catabolism (90% of reserve), and loss by protein catabolism (10% of reserves; Boertje 1985). It was assumed that fat produces 39.3 MJ/kg, and lean tissue produces 5.0 MJ/kg (Boertje 1985). Mass loss associated with a behavioural response to disturbance was calculated as total cost of disturbance (2.48 MJ) divided by [(0.9 x 39.3 MJ/kg) + (0.1 x 5.0 MJ/kg)] = 0.069 kg.

Because these encounters occurred in the post-calving and autumn periods, the costs incurred will be evident as a reduced autumn body mass (i.e., a decline in pre-winter condition). The mean reduction in autumn mass resulting in no reproduction the following spring was set at 20% of a 100 kg female (i.e., 20 kg). It was assumed that the relationship between reduced autumn body mass and parturition rate was linear. The proposed relationship is a simplified, but biologically conservative modification of that described in Cameron and Ver Hoef (1994). The Cameron and Ver Hoef (1994) model predicts that a caribou cow at 80 kg in autumn would have a parturition rate of 0.52, and demonstrates that caribou can still produce calves at lower weights than conditions set in the present analysis.

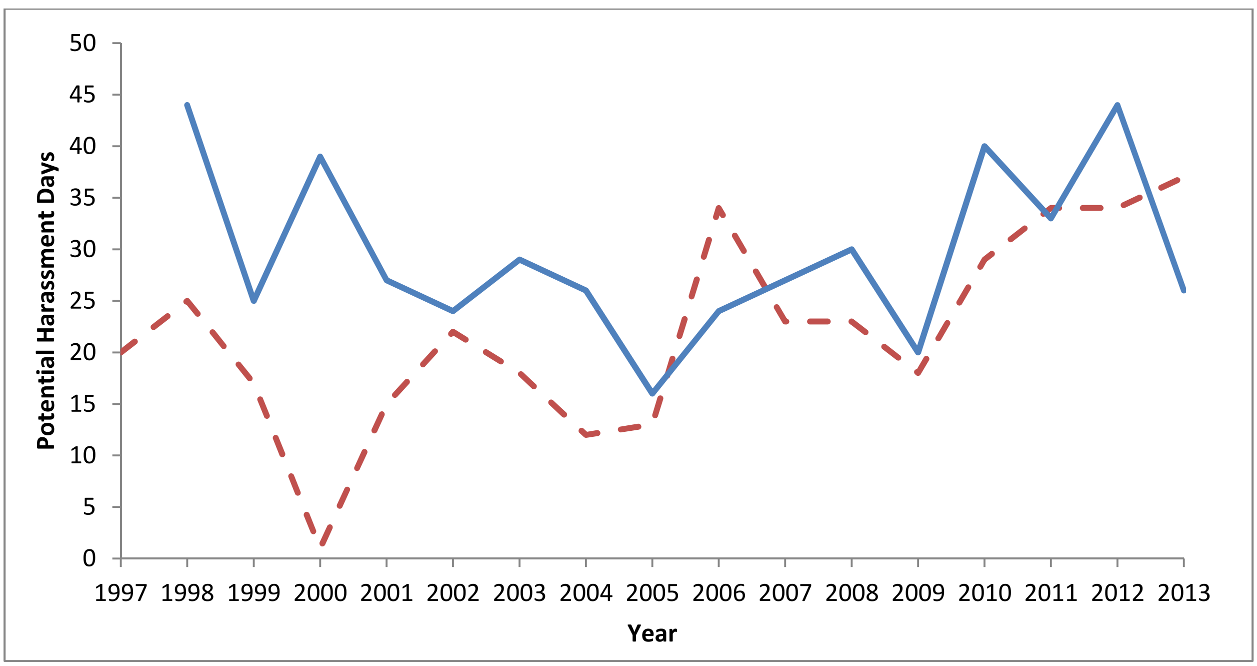
In summary, the coefficient for the rate of body weight loss from disturbance events is 0.069 kg. The following is an example showing the possible consequences of encountering industrial developments across the post-calving to autumn range of caribou. There are 138 days that caribou may be potentially exposed to zones of influence during the post-calving and autumn/rut periods (June 15 to October 31). It was assumed that female caribou would be exposed to one disturbance event per day while remaining within a ZOI. For the complementary analysis of encounter rates, it was assumed that the animal experienced one disturbance event when entering a ZOI (regardless of how close it was to the development or activity). Of the total number of encounters, it was anticipated that 55% of encounters would result in a behavioural response that would decrease body weight (Rescan 2010). Thus, if caribou encounter a ZOI 69 times or occupy a ZOI for 50% of the post-calving to autumn range (69 days of 138 days), then calf production is reduced by 13.1% the following spring, given the anticipated decrease in mean autumn body weight ([69 disturbance events x 0.55 x 0.069 kg] divided by 20 kg).

### *Insect Harassment*

Insect harassment, particularly oestrid flies, can reduce the ability of caribou to feed optimally during the fall migration (Hagemoen and Reimers 2002) and have a negative effect on body condition and fecundity (Weladji et al. 2003). As insect harassment increases, travel rates increase and feeding rates decline (Bergerud et al. 2008). Bergerud et al. (2008) argued that sensory disturbances from development have substantially fewer effects on caribou compared to the stress the animals sometimes face by oestrid flies. However, insect activity levels vary and are highly correlated with weather conditions. Overall, insect activity levels are generally low and harassment is tolerable at times in locations that are relatively cool and windy. There is substantial behavioural evidence suggesting that harassment by insects is the most important causal link between warm summer temperatures and low body condition of caribou (reviewed in Weladji et al. 2003). Ideal weather conditions for caribou occur when mid-day ambient temperatures are less than 13 degrees Celsius (°C), and when wind speeds are greater than 6 metres per second (m/s) (Weladji et al. 2003).

An insect harassment index (IHI) was developed according to Weladji et al. (2003), and was used to predict changes in body condition under varying climatic scenarios. The proposed IHI was calculated as the number of potential harassment days having mid-day ambient temperatures greater than 13°C and wind speeds less than 6 m/s (Figure 12.4-2).

**Figure 12.4-2 Insect Harassment Indices Defined as Potential Harassment Days**




Note: Calculated with meteorological data from the Diavik Diamond Mine (dashed red line) and Snap Lake Mine (solid blue line).

The IHI-autumn body weight relationship was first described for reindeer calves (*Rangifer tarandus*) in Norway, which achieve maximum autumn weights of approximately 20 kg. In the Norway study, autumn weights of calves declined at approximate rates of 0.037 kg with every 1 unit increase in IHI (Weladji et al. 2003). It was assumed that the percent change in autumn body mass for calves in the Norway study was similar for adult females in this assessment. Thus, for female caribou weighing 100 kg, it was predicted that there was a 0.185 kg decrease in body weight with every 1 unit increase in IHI (Weladji et al. 2003), which will likely overestimate effects given the higher mass-specific energy requirements of calves relative to adult females.

The proposed weight loss relationship was used in combination with regional trends in IHI (Figure 12.4-2) to estimate effects of insect harassment levels on autumn weight of female caribou, and ultimately, fecundity rate (likelihood of getting pregnant and producing a calf). However, it was assumed that adult caribou could tolerate a certain level of insect activity where there are no implications for body condition. In this assessment, the IHI threshold at which insect activity levels begin to impair caribou energetics was determined to be 15. This was the 10th percentile of the range of values from long-term climate data at two mine sites describing daily weather conditions in two areas (Lac de Gras and Camsell Lake) within the post-calving to autumn range.

Based on the relationship between the modified IHI and body weight loss in caribou, autumn body weight was defined as: [(IHI – 15) x 0.185 kg]. Pooling meteorological data (1997 to 2013) from the Diavik and Snap Lake mine sites indicated that the mean annual IHI was 26 (range = 1 to 44) (Table 12.4-26). It was assumed that this value describes typical conditions on the post-calving to autumn range of Bathurst caribou. Based on the proposed weight loss-IHI relationship and mean IHI values, female caribou could lose as much as 2.04 kg from insect harassment during an average summer. Smaller body size and poorer body condition, as indicators of habitat and weather, have direct consequences to reproduction and caribou population dynamics (e.g., Bergerud et al. 2008). Assuming that the autumn mass loss resulting in no calf production the following spring is 20% of a 100 kg female (i.e., 20 kg), an IHI value of 26 would lower parturition rates by 10.2% (2.04 kg / 20 kg).

**Table 12.4-26 Mean, Minimum, and Maximum Insect Harassment Index for the Diavik Diamond Mine and Snap Lake Mine, 1997 to 2013**

| Site | Insect Harassment Index | | | |
|---|---|---|---|---|
| | Mean | Standard Deviation | Minimum | Maximum |
| Diavik | 22 | 9.5 | 1 | 37 |
| Snap Lake | 30 | 8.5 | 16 | 44 |

Note: Measured as the number of potential insect harassment days based on Weladji's index (Weladji et al. 2003); excludes 2007 weather data for Snap Lake. Weather data from the Ekati Mine was used for missing 2011 and 2012 Diavik Mine data.

### *Overall Energetic Costs*

The overall relative decrease in the parturition rate of caribou was related to insect harassment and development-related disturbance events. The effects of disturbance events (i.e., encounters with ZOIs) and insect harassment were combined in an equation to estimate the overall effect on the caribou parturition rate:

$$\text{Proportional Decrease in Parturition Rate} = \frac{\left((IHI - 15) \times 0.185\ kg\right) + (DE \times 0.55 \times 0.069\ kg)}{20\ kg}$$

Where:

i) *IHI* is measured as oesterid harassment days;

ii) 0.185 kg is the *decline* in body mass per oesterid harassment day;

iii) *DE* is number of disturbance events, defined as one zone of influence encounter (or one day within a ZOI);

iv) 0.55 is the frequency that caribou respond to a disturbance event;

v) 0.069 kg is the decline in body mass loss per disturbance response; and,

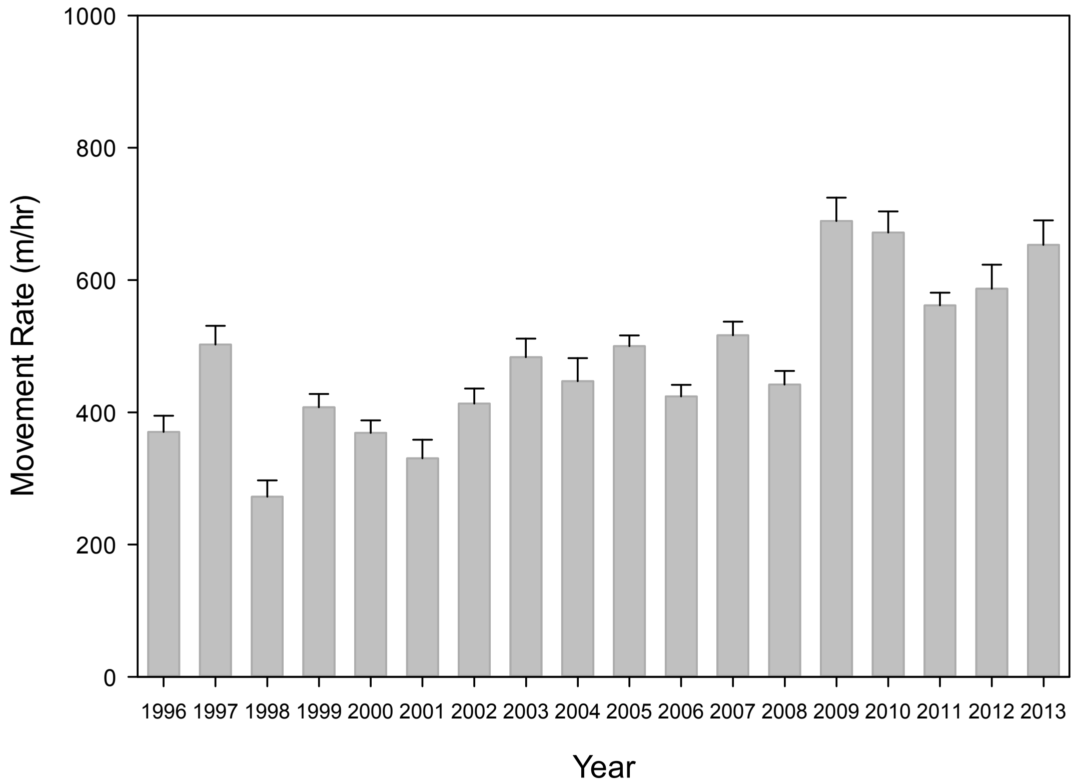
vi) 20 kg is 20% of the autumn body mass (100 kg) of a healthy caribou cow.

The model assumes that individuals do not compensate for weight loss by increasing quality food intake following a disturbance event (for example, see Dale et al. 2008), and do not become familiar (habituate) to similar disturbances (for example, see Stankowitch 2008). If caribou do increase the amount of food eaten after a disturbance and do not respond strongly to the same types of disturbance every time, then the model will overestimate the effect on the population.

#### *12.4.2.3.2 Results*

In total, 269 individual female caribou paths comprised of 36,682 partial paths or segments from the Bathurst herd were created from 7 to 22 animals per year from 1996 to 2013. On average, location data were obtained every 3.2 days per animal and year, with shorter intervals between successive locations for the latter years of the study. For example, since 2009, the mean number of days between successive location data has been approximately 0.5 days (n = 86 collared animals). In addition, the average duration of the total movement path (sum of all linear segments) was over 113 days and extended 1,068 km per animal and year (approximately 9.5 km per day). The overall mean speed of caribou movement was 480.1 m per hour (standard deviation [SD] = 117.9), and was variable across years (Figure 12.4-3).

**Figure 12.4-3 Annual Trends in Mean Movement Rate (± 1SE) for Female Caribou in the Bathurst Herd from June 15 to October 31**




m/hr = metres per hour.

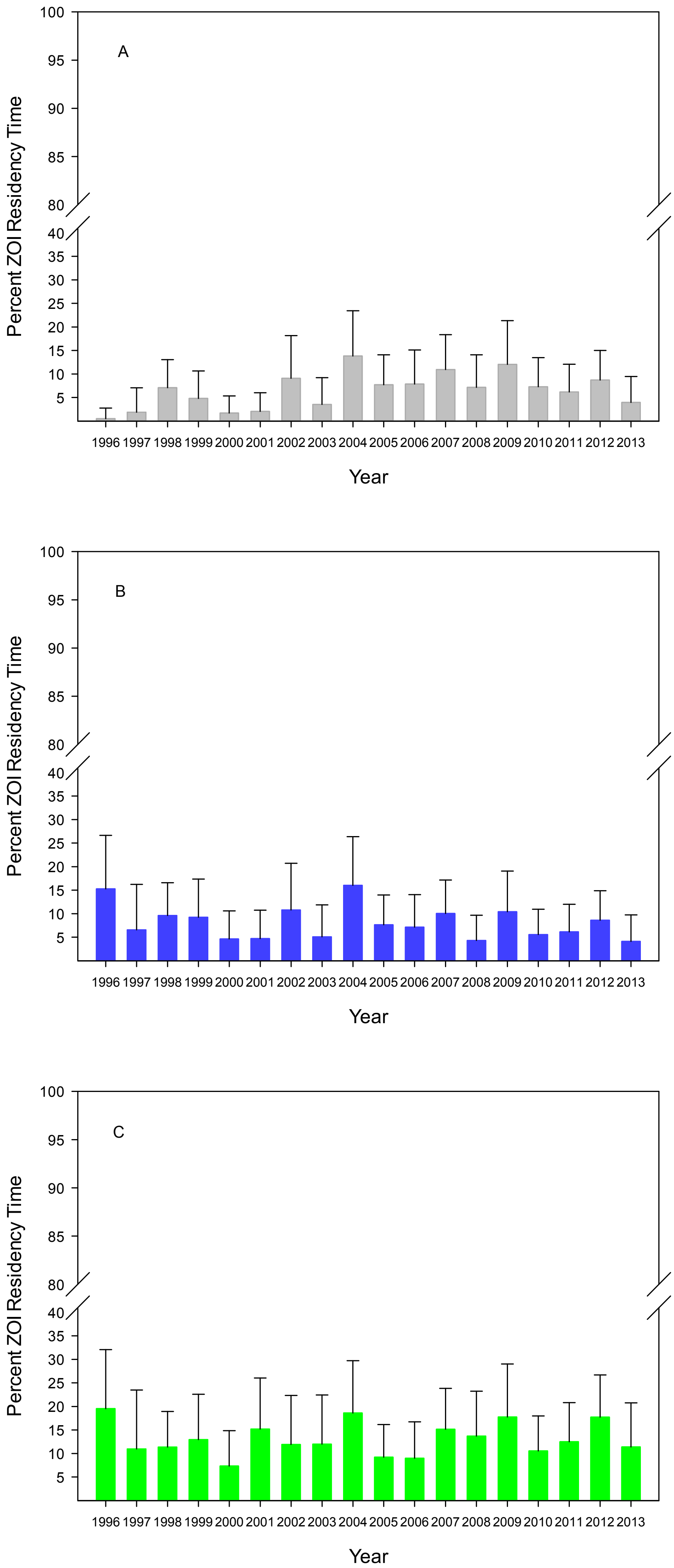
## Residency

From 1996 to 2013 (Base Case), Bathurst caribou resided in ZOIs for an average of 8.9 days (SD = 5.2 days) or 6.4% of their time during the post-calving to autumn period (n = 269 paths). The amount of time spent by female caribou in zones of influence has ranged from 0.5% in 1996 to 13.8% in 2004 (Figure 12.4-4A). The results suggest that residency time in zones of influence have increased by 0.3% annually from 1996 to 2013.

With the addition of the Project and approved developments (i.e., Lynx and Gahcho Kué projects; Application Case), simulations predicted that caribou may reside in ZOIs for an average of 11.2 days (SD = 5.0) or 8.1% of their time during the post-calving to autumn period. The amount of time female caribou were predicted to spend in ZOIs ranged from 4.1% to 16.0% (Figure 12.4-4B). Relative to the Base Case, the average amount of time female caribou spend in ZOIs is predicted to increase by 2.3% or 3 days during the post-calving to autumn period for the Application Case.

Simulations with the RFD Case predicted that caribou may reside in ZOIs for an average of 18.2 days (SD = 4.8) or 13.2% of their time during this period. Residency time in ZOIs ranged from 7.0% to 19.5% of the post-calving to autumn period using movement data from 1996 to 2013 (Figure 12.4-4C). Relative to the Application Case, the RFD Case is predicted to increase the average percent time female caribou spend in ZOIs by 7.0% or 9.7 days of the post-calving to autumn range. Relative to the Base Case, the RFD Case is predicted to increase ZOI residency time by 9.2% or 12.7 days of the 138-day post-calving to autumn range.

**Figure 12.4-4 Temporal Trend in Mean Percent Time (± 1SE) in Zones of Influence for Female Caribou in the Bathurst Herd from 1996 to 2013 for the Base Case (A), Application Case (B), and Reasonably Foreseeable Development Case (C)**



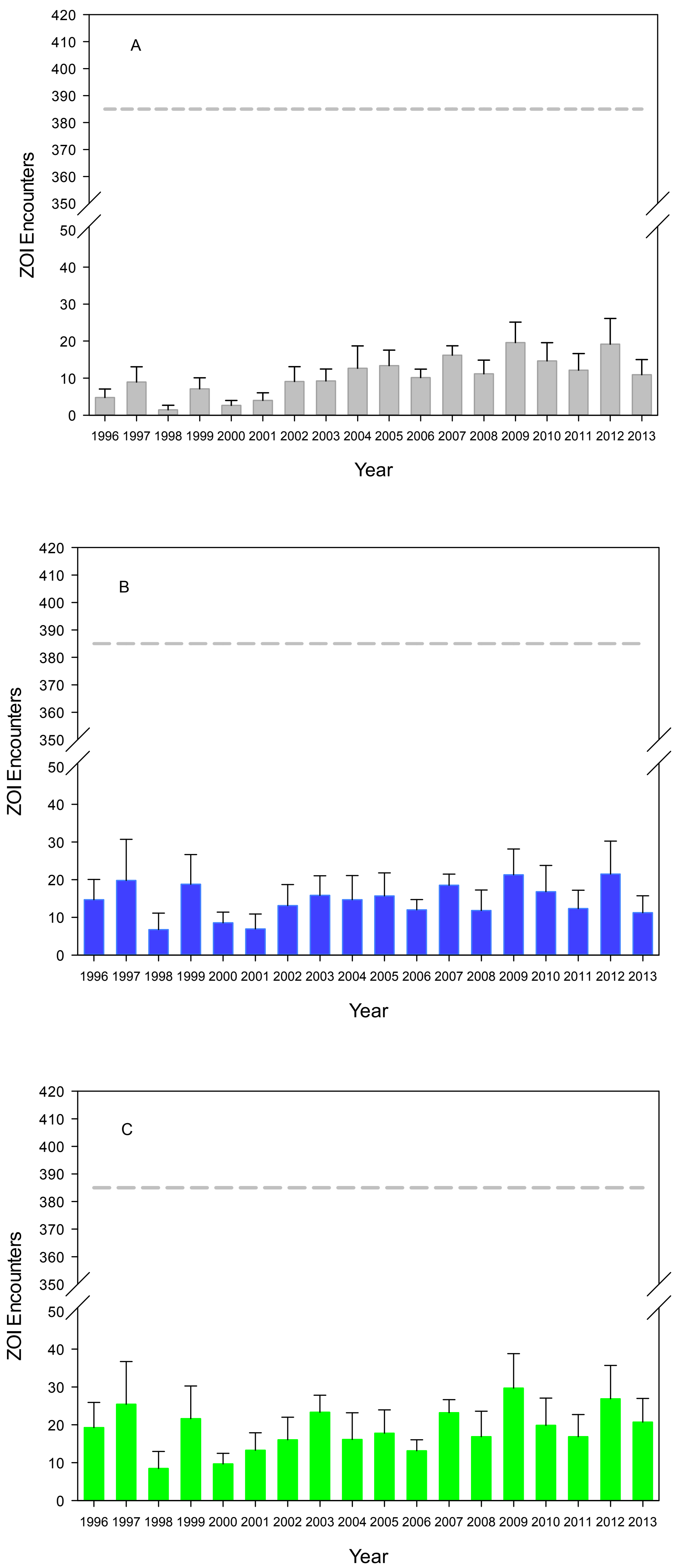

ZOI = zone of influence.

### Encounter Rates

Caribou paths monitored from 1996 to 2013 were used also to calculate the number of caribou encounters with zones of influence. Caribou residency time (i.e., percent time in zones of influence) and encounter rates were moderately correlated with each other (Pearson $r = 0.44$, $P = 0.07$). During Base Case conditions, mean annual encounter rates have ranged from 2.4 encounters per 138 days in 2000 to 18.6 encounters per 138 days in 2009 (Figure 12.4-5A). Across all years combined, the mean encounter rate with a ZOI was 8.9 encounters per 138 days (SD = 5.0) for female caribou. This encounter rate is 97.7% below the threshold encounter rate determined to result in no parturition during a severe insect year (i.e., 385 encounters). Mean annual encounter rates have increased by 0.7 encounters per year from 1996 to 2013 during Base Case conditions. Based on the 95% confidence limits of annual encounters, the maximum upper limit value was 25.7 encounters per 138 days during 2012. A 95% confidence limit accounts for uncertainty around the mean value and the upper limit represents the maximum mean number of encounters that might occur through a random draw of caribou from the same year, given the variation among caribou observed. In other words, the true mean encounter rate is expected to be no larger than this value. The maximum upper limit value of caribou paths during 1996 to 2013 is 93.3% below the encounter threshold determined to result in no parturition during a severe insect year.

The predicted number of mean annual encounters with ZOIs on the post-calving to autumn range for the Application Case ranged from 3.0 to 20.4 using movement data from 1996 to 2013 (Figure 12.4-5B). Across all years combined, the overall mean encounter rate was 12.5 encounters per 138 days (SD = 5.1). This value is 96.8% below the threshold of 385 encounters determined to result in no parturition during a severe insect year. The maximum 95% confidence limit is 30.6 encounters per 138 days, which is 92.1% below the threshold determined to result in no parturition during a severe insect year. With the addition of the Project and approved developments to the post-calving to autumn range, simulations predicted that an annual average of 3.5 additional encounters per 138 days (SD = 3.3) may occur relative to the Base Case.

**Figure 12.4-5 Temporal Trend in Mean Encounter Rates (± 95% Upper Interval) with Zones of Influence for Female Caribou in the Bathurst Herd from 1996 to 2013 for the Base Case (A), Application Case (B), and the Reasonably Foreseeable Development Case (C). Also shown is the reference threshold of 385 encounters (dashed line) estimated to result in no parturition during a severe insect year**




ZOI = zone of influence.

The anticipated encounter rate with ZOIs on the post-calving to autumn range through the RFD Case was higher than the Baseline and Application case (Figure 12.4-5C). The number of mean annual encounters ranged from 4.0 to 28.2 using movement data from 1996 to 2013. Across all years combined, the mean annual encounter rate was 16.1 encounters per 138 days (SD = 6.5). This encounter rate value is 95.8% below the threshold determined to result in no parturition during a severe insect year. The maximum 95% confidence limit is 38.3 encounters per 138 days, which is 90.1% below the threshold determined to result in no parturition during a severe insect year. Relative to the Application Case, the RFD Case simulations predicted that an annual average of 3.6 additional encounters per 138 days (SD = 2.3) may occur. Relative to the Base Case, the RFD Case is predicted to result in an average of 7.2 more encounters per 138 (SD = 4.1) days during the post-calving to autumn period.

## Energetic Costs from Development and Insect Harassment

Assuming that caribou are exposed to one major disturbance event per day when residing within a ZOI, then residency times from 1996 to 2013 suggest that caribou encounter an average of 8.9 disturbance events during post-calving and autumn movements. Under the Base Case, residency time with ZOIs predict that caribou can encounter up to 16.6 disturbance events. In contrast, the analysis of caribou paths entering zones of influence predicted that the mean number of disturbance events was 8.9 from 1996 to 2013. Under the Base Case, encounter rates predict that female caribou may be influenced by 18.6 disturbance events. For both analyses, it was assumed that when an animal entered or resided in a ZOI, the animal experienced a disturbance event regardless of how close it was to the development or activity.

For energetics modelling and analyses, the estimated ZOI encounter rates (Figure 12.4-5) were used to predict the number of disturbance events that female caribou may experience under different landscape scenarios. Encounter rate typically generated a higher number of disturbance events than residency time. Using maximum mean annual values for the Base Case (1996 to 2013), and the Application and RFD cases (Figure 12.4-5), it was predicted that female caribou encounter 19, 21, and 28 disturbance events, respectively, during the post-calving to autumn (Table 12.4-27). Under reference conditions, the number of disturbance events encountered was set at zero.

In a landscape with negligible disturbance from insects and development (i.e., ideal conditions) the fecundity rate in the population may theoretically approach 1.0 or 100%. However, even with no development, individuals are subject to other natural factors that can cause stress and associated loss of energy reserves so that they do not achieve ideal autumn body weight (e.g., fluctuations in forage quality, and avoiding predators). For the assessment, it was assumed that fecundity was maximum (i.e., 1.0) under reference conditions. This condition was conservative because it assumes that the rate of decrease in body mass relative to the 20 kg threshold is equal to the rate of decrease in fecundity. Ideal (reference) conditions provide a null model for determining the independent effects from development and insects on caribou fecundity.

With low insect harassment and no development, the model predicts a 0.0% decrease in fecundity for some females and in some years (i.e., parturition rate = 1.0; Table 12.4-27) relative to ideal conditions. The reference values for parturition and fecundity rates are within the range of upper values observed for caribou (Cameron et al. 2005; Boulanger and Gunn 2007). In a year with severe insect harassment and no development on the landscape, fecundity may be reduced by 26.8%.

**Table 12.4-27 Modelled Effects of Various Landscape Developments and Insect Harassment Intensities on Fecundity Rates of Caribou**

| Scenario | Insect Harassment Index | Disturbance Encounters[(a)] | % Decrease in Parturition/ Fecundity[(b)] | Parturition Rate for Females at Prime Age[(c)] |
|---|---|---|---|---|
| Reference, low IHI | 15 | 0 | 0.0 | 1.000[(d)] |
| Reference, average IHI | 26 | 0 | 10.2 | 0.898 |
| Reference, high IHI | 44 | 0 | 26.8 | 0.732 |
| Base Case, low IHI | 15 | 19 | 3.6 | 0.964 |
| Base Case, average IHI | 26 | 19 | 13.8 | 0.862 |
| Base Case, high IHI | 44 | 19 | 30.4 | 0.696 |
| Application Case, low IHI | 15 | 21 | 3.9 | 0.961 |
| Application Case, average IHI | 26 | 21 | 14.2 | 0.858 |
| Application Case, high IHI | 44 | 21 | 30.8 | 0.692 |
| RFD Case, low IHI | 15 | 28 | 5.3 | 0.947 |
| RFD Case, average IHI | 26 | 28 | 15.5 | 0.845 |
| RFD, high IHI | 44 | 28 | 32.2 | 0.678 |

a) Cause caribou to increase movement, run, become excited and metabolize stored energy (=mean residency time in ZOIs x 138 days). Maximum encounter rates were used for Base Case (1996 to 2013), and simulated Application and RFD cases.

b) Proportional Reduction = [((IHI – 15) x 0.185 kg) + (disturbance events x 0.55 x 0.069 kg] / 20 kg (see equation in Section12.4.2.3.1).

c) Reference value – (percent decrease (b) x reference value).

d) Assumed reference parturition rate.

IHI = Insect Harassment Index;% = percent; RFD = reasonably foreseeable development ; ZOIs = zones of influence; kg = kilogram.

To be similar with the habitat suitability modelling and results, landscape development scenarios included the following: reference (no development) condition, Base Case, Application Case, and RFD Case. However, unlike the habitat modelling, the approved developments (i.e., Lynx and Gahcho Kué projects) were included in the Application Case with the Project. Separating the Lynx and Gahcho Kué projects from the Jay Project (particularly the Lynx project) would provide no additional ecological understanding of the cumulative effects from development on caribou parturition rate. The approach is to understand the cumulative effects on caribou parturition rate from reference conditions through the Application Case (which includes the Base Case), followed by the RFD Case.

For the Base Case with low levels of insect harassment, the model predicted a reduction in fecundity by 3.6% relative to reference conditions (Table 12.4-27). For the Application Case and low insect harassment, the fecundity rate was reduced by 3.9% relative to reference conditions. Thus, the incremental decrease in fecundity from the Project and the Lynx and Gahcho Kué projects relative to the Base Case was predicted to be 0.3% lower fecundity (difference from 3.6% to 3.9%). With cumulative encounters carried through the RFD Case, fecundity decreased by 5.3% from reference conditions. The energetic model predicts that insect levels have the largest influence on fecundity.

For those summers when insect harassment is low, female encounters with disturbance would be required to exceed 525 disturbance events so that there is an expenditure of 20% of 100 kg (i.e., 20 kg), and no calf production the following year. If considering the effects from severe insect harassment and disturbance encounters, then approximately 385 disturbance events per individual would be required to reduce parturition to zero, resulting in no calf production. Based on the expected number of disturbance encounters for current landscape conditions with the Project and future developments (approximately 28), female caribou would have to increase their encounter rate per day by approximately 14 to19 times to result in no calf production the following spring.

### 12.4.3 Residual Effects Summary

Direct disturbances from previous and existing developments and approved projects up to 2014 baseline conditions have resulted in less than 1.4% declines in the area of any habitat in any seasonal range, except for rock association. Rock association is habitat that appears as barrenlands in the Canada 250-m Land Cover Time Series. It is a preferred caribou habitat in the spring range, where the reference condition to 2014 baseline condition decline was 5.4%; in other seasons, it was neither selected nor avoided by caribou. With the addition of the Project there was a less than 0.1% reduction in area for any habitat in any season. The Project footprint did not intersect with the winter range and there was no change in the winter range disturbance area.

The magnitude of cumulative direct disturbance from the Project and from all previous, existing, and reasonably foreseeable future developments is predicted to be less than 0.6% of the total area in each seasonal range. Rock association covered 0.31% of the spring range in reference conditions and 0.29% in 2014 baseline conditions; it is expected to continue to cover 0.29% of the spring range in the Application and RFD cases.

The largest absolute number of habitat patches lost from the reference condition to the 2014 baseline condition occurs in the winter range. From 55 (mixedwood) to 230 (bog/fen habitat) patches of habitat have been removed by previous and existing developments. Previous and existing developments increased the number of coniferous (by 109 patches [0.17%]), water (by 70 patches [0.08%]), and burn (by 37 patches [4.46%]) patches in the winter range. The number of habitat patches removed by previous and existing developments in the spring, post-calving, and autumn ranges were from 0 to 45 (sedge association habitat, autumn range) patches. The largest decrease in the number of patches in the spring, post-calving, and autumn ranges from reference to 2014 baseline conditions occurred in rock association habitat (0.78% in spring range, 1.97% in post-calving range, and 2.25% in autumn range).

The Project footprint covers approximately 1,132 ha of the ESA (less than 0.01%). Approximately 62% of the physical footprint is terrestrial habitat and 38% is aquatic habitat. It is estimated that 4 ha of esker will be disturbed by the Project. The Project is predicted to remove one patch of riparian shrub habitat and three patches of sedge association habitat in the spring, post-calving, and autumn ranges, relative to the 2014 baseline condition. The Project will not remove any habitat patches in the winter range.

Tundra ecosystems are slow to recover from disturbance. The terrestrial area that contains the Project footprint is considered a permanent disturbance on the landscape because the time for vegetation to recover, and it is not known what the reclaimed landscape will look like in the future. The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas. Early successional stages of planted vegetation may provide suitable forage for caribou.

The largest absolute decrease in number of patches from the reference condition to the RFD Case occurs in the winter range. From 64 (exposed land/rock) to 257 (bog/fen) patches are predicted to be removed by developments in the winter range). In the winter range, previous, existing, and reasonably foreseeable developments are predicted to increase the number of water (44 patches), burn (41 patches), and coniferous (139 patches) habitat patches, relative to the reference condition. The largest absolute decrease in number of habitat patches in the spring, post-calving, and autumn ranges occurs in sedge association habitat (60 patches removed in spring range). The largest relative decrease in number of habitat patches in the spring, post-calving, and autumn ranges occurs in rock association habitat (2.25% and 2.19% loss in autumn and post-calving ranges, respectively).

The largest absolute increase in the mean distance between nearest neighbour between the reference condition and the 2014 baseline condition occurs in esker habitat in the post-calving range (increase of 15 m), followed by rock association habitat in the autumn range (increase of 12 m). The largest increase in mean distance to nearest neighbour from the 2014 baseline condition to the Application Case occurs in esker habitat in the post-calving range (increase of 1 m). All other changes to the mean distance to nearest neighbour in the caribou seasonal ranges were less than 1 m between the 2014 baseline condition and the Application Case. The mean nearest neighbour distance between burn patches is predicted to decrease by 86 m in winter between the reference condition and the RFD Case. All other nearest neighbour distances are expected to change by less than 0.8% for any habitat in any season.

From reference conditions to 2014 baseline conditions, losses of preferred habitat in the four seasonal ranges was from 0.9% to 6.0%, which included physical footprints and ZOIs. With the application of the Project to the landscape, predicted additional decreases in preferred habitat are from 0.0% to 0.2% among the four seasonal ranges. Reductions in preferred habitat from reference conditions to RFD Case are 1.7% of the spring range, 13.3% of the post-calving range, 12.0% of the autumn range, and 5.9% of the winter range.

The power line along the Misery and Jay roads is expected to have smaller effects on caribou than the roads and associated traffic levels. If caribou movements and distribution change during the construction and operation of the Project it is more likely that these changes will be due to the increased traffic volume on the roads. Mitigation and adaptive management using the results from monitoring are anticipated to limit the effects on caribou movements and distribution from the Misery and Jay roads.

Encounters of collared barren-ground caribou with the ZOIs around previous and existing developments in the post-calving to autumn period were variable among years. From 1996 to 2013, the maximum number of caribou interacting with developments was estimated at 18.6 encounters per individual in the post-calving to autumn period. Using these same data, simulations with the Project and approved developments predicted 20.4 encounters. The RFD Case is expected to add an average of 7.2 encounters per individual. With high levels of insect harassment and RFD Case developments, the predicted decline in parturition rate may be as high as 32%. Insect harassment is the key variable in the model. Even in a landscape with no human development (i.e., reference conditions), high insect harassment was predicted to cause a 26.8% decline in parturition rate. In comparison, during the RFD Case where the effect of human development is largest, a year with low insect harassment is predicted to cause a decrease of 5.3%, a year with moderate insect harassment is predicted to cause a 15.5% decrease in parturition rate, and a year with high insect harassment is expected to cause a 32.2% decline in parturition.

Although the incremental changes to habitat quantity and quality from each active development occur at the local scale, the cumulative effect on the movement and behaviour of caribou extends to the population within the ESA (i.e., regional geographic extent). The duration of effects on the Bathurst herd from changes in habitat quality, altered movement and behaviour, and energetics are expected to be reversed within 5 to 10 years following the end of closure (i.e., perhaps 5 to 10 years after sensory disturbance associated with a project is no longer present).

## 12.5 Prediction Confidence and Uncertainty

The purpose of the prediction confidence and uncertainty section is to identify the key sources of uncertainty and to discuss how uncertainty has been addressed to increase the level of confidence that effects are not worse than expected. Confidence in the residual effects analysis and assessment of environmental significance is related to the following elements:

- adequacy of baseline data for understanding current conditions and future changes unrelated to the Project (e.g., extent of future developments, climate change);
- model inputs (e.g., ZOI and DCs from developments);
- understanding of Project-related effects on complex ecosystems that contain interactions across different scales of time and space (e.g., exactly how the Project will influence caribou); and,
- knowledge of the effectiveness of the environmental design features (mitigation) for reducing or removing effects (e.g., modifying traffic along the Misery Road to limit effects to movement and behaviour of caribou).

It is anticipated that the baseline data are sufficient for understanding current conditions and future changes not related to the Project, and that there is a moderate to high level of understanding of Project-related effects on the ecosystem. There is good information on the effects from mining activity on caribou in the area surrounding Lac de Gras (e.g., Johnson et al. 2005; Golder 2011a; Boulanger et al. 2012; Golder 2014d; ERM Rescan 2014a,b). Confidence in the prediction that the Project will disturb plant populations and communities near the facilities and roads is high. Disturbances to vegetation will affect barren-ground caribou habitat and the behaviour and movement of caribou. However, long-term monitoring studies documenting the resilience of caribou to development and the time required to reverse impacts are lacking.

Adding to the challenges of understanding complex systems is the difficulty of forecasting a future that may be outside the range of observable baseline environmental conditions (Walther et al. 2002). For example, natural factors such as the 2014 forest fires in the NWT can also influence caribou. The number, frequency, and severity of wildfires in many parts of the world have increased from 1960 to 2013 (Bladon et al. 2014). Climate change and fire suppression practices are thought to be the largest contributors to the trend. A recent prediction for Canada indicates the potential for a 74% to 118% increase in average burn area by the end of this century (Flannigan et al. 2005). Fire alters many components of the environment including air quality, water quality, soil characteristics, vegetation cover, and hydrological processes.

Fire is a natural part of arctic and boreal ecosystems, and soils and plants have adapted to them. Fires are generally larger, more intense, and more severe in forested areas and near the treeline than in open tundra areas (Wein 1976; Gustine et al. 2014) because there is more fuel and fire can generate enough energy to jump streams, lakes and areas of wet or moist vegetation (Wein 1976). Further north in tundra areas the amount of fuel is limited and so fire cannot generate enough energy to burn through moist areas, into the wind, or downhill (Wein 1976). As such, most fires that occur in the tundra are small (less than 1 $km^2$), although large fires (covering tens of thousands of square kilometres) have occurred (Wein 1976; Gustine et al. 2014). The risk of a large fire near the Project is low because of its northern location in the tundra of the NWT. However, long-range transport of smoke from large fires in the circumpolar boreal forest can change air quality near the Project (Warneke et al. 2010). Atmospheric deposition of soluble gases and particulates produced by boreal fires can change soil and vegetation characteristics, and wildlife habitat (Bobbink et al. 1998; Rusek and Marshall 2000; Jung et al. 2011).

Smoke from boreal forest fires can contain hundreds of different compounds in both the gas and particulate phases (Mahaffey and Miller 1994; Core and Peterson 2001). Smoke composition depends on fuel composition and fire type (e.g., active flaming fires versus smoldering fires), but is dominated by emissions of water vapour, oxides of carbon (CO, $CO_2$), oxides of nitrogen ($NO_x$), non-methane hydrocarbons (NMHC), volatile organic compounds (VOCs), and fine particulate matter ($PM_{2.5}$). Atmospheric lifetimes of soluble gases and $PM_{2.5}$ emitted from boreal forest fires are three to ten days. Their emission can create regional hazes that can be transported thousands of kilometres in the lower troposphere (McKeen et al. 2002). Fine particulates serve as cloud condensation nuclei and are removed via wet deposition (e.g., rain or snow). Most soluble gases are also removed by precipitation events. Dry deposition rates are typically low, but can be high close to active fires, and during intense or persistent regional haze events. Overall, changes to air quality from forest fire smoke, especially large fires in the boreal forest, are predicted to result in short-term changes to soil and vegetation quality on the tundra habitats of caribou ranges, and are not anticipated to alter the predictions of effects from the Project on caribou.

In contrast, fires in the boreal forest can result in large and long-term changes to the winter range of barren-ground caribou herds. Climate change can cause the frequency and intensity of fires to be unpredictable, which generates uncertain effects on caribou because of the variation in the amount, length of time and spatial extent of changes to the winter range. Fire reduces habitat and food resources (e.g., lichens) for caribou, and affects all age groups at the same time (Vors and Boyce 2009). Fire also results in the production of early successional forest, which can increase the number of moose, deer and wolves on the winter range and negatively affect caribou populations (Sharma et al. 2009). Traditional knowledge contends that fire frequency and intensity affects caribou numbers and distribution (Kendrick et al. 2005). The Tłı̨chǫ observed that caribou avoid burned areas, and that climate change has changed snow and ice conditions, which may be why caribou appear skinnier now than in the past (Section 12.2.3.6). Climate change may also influence summer ranges of caribou through changes in forage quality and abundance, the timing of plant growth, and insect harassment (Lenart et al. 2002; Weladji and Holand 2003; Vors and Boyce 2009; Kerby and Post 2013).

Although quantitative and less biased than models based on expert opinion, RSF-based habitat models have numerous sources of uncertainty; these sources include the structure of the models, the accuracy and precision of underlying data layers, and biases associated with the chosen GIS algorithms (Burgman et al. 2005). Studies of resource selection, like studies of movement, can benefit from including temporally dynamic environmental data (Avgar et al. 2012) that were absent in the creation of the RSFs available for the ESA. The habitat layers derived from RSF models are a static view between a caribou and their environment, ignoring intra-seasonal variation and changes over time with ecological succession and natural disturbances such as fire. Further, the data from which the RSF models were derived were collected when the Bathurst herd was in decline, and may not reflect habitat value to caribou in the population as accurately during other phases of the population cycle.

When considering the predictions on the effects of the Project and other developments on barren-ground caribou habitat, sources of uncertainty were reduced by using multiple habitat mapping methods (Burgman et al. 2005). For example, the assessment included fragmentation analyses and the use of RSF habitat models, which together limit bias and imprecision in predictions. Several conservative assumptions were implemented in the analyses across scales from the individual animal to the seasonal range of the population to address uncertainty and improve confidence of impact predictions.
The conservative assumptions used and their implications to effects estimates for caribou are presented in Table 12.5-1.

**Table 12.5-1 Conservative Assumptions Implemented to Reduce Uncertainty and Improve Prediction Confidence for Barren-Ground Caribou**

| Effects Pathway | Conservative Assumption | Implication to Effect |
|---|---|---|
| Habitat Quantity and Fragmentation | Undisturbed habitat within the Project footprint and other development footprints is unavailable to caribou | Overestimates habitat loss and fragmentation effects |
| | Larger than expected footprint size used when size was not known | Overestimates habitat loss and fragmentation effects |
| | Inclusion of winter road portage footprints during non-winter periods | Maximizes the amount of disturbance during non-winter periods |
| | Footprints for closed mines and inactive land use permits were carried through all assessment periods | Overestimates habitat loss and fragmentation effects |
| Habitat Quality, Behaviour and Movement | Large zones of influence around developments | Overestimates the spatial extent and magnitude of sensory disturbance effects on habitat quality and behaviour |
| | | Captures extent of noise levels from the Project that are greater than 40 to 55 dBA |
| | The section of the Tibbitt to Contwoyto Road that is north of the Lac de Gras region was assumed to be active (a zones of influence was applied in the models), even though this portion of the road has not been constructed since 2008 | Overestimates the spatial extent and magnitude of sensory disturbance effects on habitat quality and behaviour |
| | The greater disturbance coefficients was used when zones of influence overlapped | Overestimates the spatial extent and magnitude of sensory disturbance effects on habitat quality and behaviour |
| | Larger than expected footprint size used when size was not known and zones of influence began at outer limit of footprint | Overestimates the spatial extent and magnitude of sensory disturbance effects on habitat quality and behaviour |
| | Disturbance coefficients and zones of influence retained in all time periods, and did not account for potential habituation to disturbance effects or reduced effects in some seasons | Overestimates the temporal and spatial extent and magnitude of sensory disturbance effects on habitat quality and behaviour |
| | Zone of influence duration was for the entire permit period for exploration | Overestimates the temporal and spatial extent and magnitude of sensory disturbance effects on habitat quality and behaviour |

**Table 12.5-1 Conservative Assumptions Implemented to Reduce Uncertainty and Improve Prediction Confidence for Barren-Ground Caribou**

| Effects Pathway | Conservative Assumption | Implication to Effect |
|---|---|---|
| Behaviour, Energy Balance, and Calf Production | Caribou do not habituate to disturbance effects | Overestimates the energetic costs of disturbance |
| | Application of a linear relationship between number of disturbance encounters and subsequent body mass loss and decline in parturition | Overestimates the energetic costs of small numbers of encounters |
| | 20% (20 kg) threshold of no parturition for energetics model | Smaller than usual margin of body mass loss for no parturition |
| | Flight response to disturbance event plus 12-hour agitation period | Severe response overestimates energetic cost of a disturbance event Estimated zones of influence have been shown to have a gradient effect; the assessment used binary approach (i.e., effect was equal regardless of how far caribou were from development) |
| | Caribou can tolerate lower levels of harassment | Under emphasizes the influence of insect harassment on body mass loss and parturition rates (i.e., mass loss from insect harassment begins at higher levels of harassment) |
| | Caribou would not cross Misery or Jay roads | Severe response overestimates energetic cost of deflection movements |
| | Equal effect on caribou body mass from encounters with zones of influence regardless of distance from development, even though estimated zones of influence have been shown to have a gradient effect on caribou distribution | Overestimates energetic cost of a disturbance event |
| | Maximum mean annual disturbance events used to calculate energetic cost | Estimates energetic cost with a higher than average encounter rate |
| | No compensatory foraging outside of ZOIs | Mass loss from an encounter cannot be offset by supplemental foraging |

% = percent; kg = kilogram; dBA = A-weighted decibels.

To reduce uncertainty associated with changes in habitat, conservative assumptions were implemented to overestimate habitat loss and fragmentation. In habitat assessments, undisturbed habitat occurring within development footprints was calculated as lost or unsuitable although caribou have been observed to use these areas. Habitat loss was also over estimated by assuming larger than expected footprints for developments. For example, a 500-m radius was used to estimate the area of the footprint for exploration sites (78.5 ha). This approach likely overestimates direct habitat loss because drilling activities are generally completed in the winter to avoid rutting from the drilling rig and on-site vehicles. As well, rights-of-way for roads and transmission lines were assumed to be 250 m (200 m in winter) though actual footprints are expected to be much narrower.

The approach to reduce uncertainty associated with changes in habitat quality, and altered movement and behaviour of caribou also included assumptions intended to overestimate spatial effects of sensory disturbance. Estimates of the resource selection coefficients and ZOI applied were based on results for Bathurst caribou (Johnson et al. 2004, 2005; Boulanger et al. 2012) and other published scientific literature on caribou and reindeer (Vistnes and Nelllemann 2008). The duration of activity on the landscape was also overestimated. Zones of influence were also applied to all active exploration sites for the entire permit period even though activities typically do not occur throughout the year, and some sites may have been abandoned before permit expiration. Other than for winter roads, footprints, ZOIs, and DCs for developments were held constant across seasons, even though studies have detected seasonal decreases in effects from human activities and infrastructure on caribou (Polfus et al. 2011).

The magnitude of changes to caribou movement and behaviour from the power lines along Misery and Jay roads compared to the physical presence of the roads and associated traffic is unknown. Research suggests that effects from power lines are minor when compared to active roads (Berger et al. 2000; Reimers et al. 2000, 2007; Vistnes et al. 2008). However, little specific research has been completed on how low voltage distribution lines affect caribou movement and distribution.

An energetics model determined the cumulative losses of body weight in a female caribou from insect harassment and development ZOIs during the post-calving to autumn period and the related probability of producing a calf the following spring. Energy expenditures for model inputs and rate assumptions came from multiple scientific publications (e.g., Cameron and Ver Hoef 1994; Bradshaw et al. 1998; Cameron et al. 2005). In addition to having a scientific basis, the energetics model incorporated several conservative conditions so that body mass loss would not be underestimated across the post-calving to autumn period. For example, the energetics model assumed that a 20 kg loss by a 100 kg caribou cow would result in no calf production. In contrast, the Cameron and Ver Hoef (1994) model predicts that a caribou cow at 80 kg in autumn would have a parturition rate of 0.52, and demonstrates that caribou can still produce calves at lower weights than conditions set in the current analysis.

Calculations of energy loss assumed that caribou can tolerate a certain level of insect harassment. Insects are part of the natural environment in which caribou have evolved so it is plausible that a tolerance threshold exists, although the actual value is unknown. For example, the results of Witter et al. (2012) indicated that insect avoidance behaviour becomes the dominant group behaviour when black fly harassment reaches moderate intensity levels. By including a tolerance level, body mass and effects to parturition does not occur until there a higher levels of insect harassment. In the model, the initial response to human disturbance was assumed to last 15 minutes; however, results of behaviour monitoring at the Ekati Mine indicate caribou resume non-stressed behaviour (running, trotting) within one minute (ERM Rescan 2014b).

The model also included a deflection cost that assumed caribou would not cross the Misery and Jay roads (i.e., a complete barrier effect), and would be required to travel using longer alternate routes to continue migration through the Lac de Gras area. Results of camera monitoring at the Ekati Mine from 2011 to 2013 indicate that caribou do cross the Misery Road, which suggests that it is not acting as a complete barrier to caribou movements (ERM Rescan 2014a). Calculations of energetic costs used higher than average encounter rates and assumed no compensatory feeding by caribou outside of ZOIs, resulting in larger body mass loss than might be expected (Dale et al. 2008). Finally, the calculations do not account for possible habituation to disturbances as reported for other migratory caribou populations (Haskell and Ballard 2008; Johnson and Russell 2014).

The assumptions and conditions applied to the models and analyses were designed to overestimate effects from disturbance by creation of worst-case scenarios. The use of worst-case scenarios provides confidence that the assessment has not underestimated the environmental effects of the incremental and cumulative effects from the Project and other developments on caribou.

# 12.6 Residual Impact Classification and Significance

## 12.6.1 Methods

### *12.6.1.1 Residual Impact Classification*

The purpose of the residual impact classification is to describe the incremental and cumulative adverse effects from previous, existing and approved developments, and the Project (Application Case), and future developments (RFD Case) on caribou using a scale of common words rather than numbers and units. The use of common words is accepted practice in environmental assessment.

Results from the residual impact classification are then used to determine the environmental significance from the Project and other developments on the assessment endpoint for caribou. Effects are described using the criteria defined in Table 12.6-1, and reflect the impact descriptors provided in the Terms of Reference (Appendix 1A, Section 4.1). Together, these criteria are used to describe the nature (e.g., severity or intensity of change, and the area and amount of time over which the change occurs) and type (e.g., direction of the change) of an effect on caribou. The main focus of the DAR is to predict whether the Project is likely to cause a significant adverse (i.e., negative) effect on the environment. Therefore, positive effects are not assessed for significance.

DOMINION DIAMOND

**Table 12.6-1 Definitions of Residual Impact Criteria Used to Evaluate Significance for Barren-Ground Caribou**

| Criteria | Rating | Definition |
|---|---|---|
| Magnitude | Low | Amount of change to measurement indicator results in no measurable effect on population abundance and distribution, or results in a minor measurable residual effect on the population |
| | Moderate | Amount of change to measurement indicator results in a clearly defined change to population abundance and distribution, but the residual effects are well within the predicted resilience limits and adaptive capacity of the VC |
| | High | Amount of change to the measurement indicator is sufficiently large that the resulting range of residual effects are near or exceeding the predicted resilience limits and adaptive capacity of the VC |
| Geographic Extent | Local | Predicted maximum spatial extent of direct and indirect effects from changes to measurement indicators due to a project or activity |
| | Regional | Residual effects from changes to measurement indicator due to a project or activity exceed the local scale and/or can include cumulative effects from other developments in the ESA |
| | Beyond Regional | Residual cumulative effects from changes to measurement indicator due to a number of developments extend beyond the ESA |
| Duration | Short-term | Residual effect from change to measurement indicator is reversible at end of construction of a project |
| | Medium-term | Residual effect from change to measurement indicator is reversible at end of operations of a project |
| | Long-Term | Residual effect from change to measurement indicator is reversible within a defined length of time past closure of a project |
| | Permanent | Residual effect from change to measurement indicator is irreversible |
| Frequency | Infrequent | Residual effect from change to measurement indicator is confined to a specific discrete event |
| | Frequent | Residual effect from change to measurement indicator occurs intermittently |
| | Continuous | Residual effect from change to measurement indicator occurs continuously |
| Reversibility | Reversible | Residual effect from change to measurement indicator is reversible within a time period that can be identified when a development or activity no longer influences the population |
| | Irreversible | Residual effect from change to measurement indicator is predicted to influence the population indefinitely (duration is permanent or unknown) |
| Likelihood | Unlikely | Residual effect from change to measurement indicator is possible but unlikely (<10% chance of occurrence) |
| | Likely | Residual effect from change to measurement indicator may occur, but is not certain (10% to 80% chance of occurrence) |
| | Highly Likely | Residual effect from change to measurement indicator is likely to occur or is certain (80% to 100% chance of occurrence) |

Note: resilience is the ability of a population to recover or bounce back from disturbance; it varies among VCs.

VC = valued component; ESA = effects study area; <= less than;% = percent.

**Magnitude** – Magnitude is a measure of the intensity of a residual effect on a VC. For example, magnitude can represent the degree of change caused by the Project relative to baseline conditions (i.e., effect size). Magnitude is VC-specific and is classified into three scales: low, moderate, and high. For caribou, magnitude is a function of the numerical and qualitative changes in measurement indicators and the associated influence on the abundance and distribution of the population. Project-specific (incremental) and cumulative changes in physical (e.g., habitat quantity, quality, and fragmentation) and biological (e.g., survival, reproduction, movement, and behaviour) measurement indicators result in effects on the abundance and distribution of caribou populations. Because the assessment endpoint for caribou is a self-sustaining and ecologically effective population, the magnitude of residual effects is assessed at the population level. Self-sustaining populations are healthy, robust populations capable of withstanding environmental change and accommodating random demographic processes (Reed et al. 2003). Traditional knowledge and science understand that caribou have strong effects on ecosystem structure and function and the concept of ecologically effective populations also is used (Soulé et al. 2003). An ecologically effective population of a highly interactive species is one that is large enough to maintain ecosystem function.

To provide an ecologically relevant classification of effect sizes of changes in measurement indicators for caribou, the assessment of magnitude included the known or inferred ability of the population to absorb or otherwise accommodate disturbance. The evaluation and classification of magnitude considers the adaptive capacity and resilience of caribou to absorb effects from the Project and other disturbances, and continue as a self-sustaining and ecologically effective population. Adaptable VCs can change their behaviour, physiology, or population characteristics (e.g., birth rate) in response to a disturbance such that there is little change in abundance and distribution. For example, behavioural plasticity allows for adaptation to disturbance, high birth rates allow for replacement of harvested individuals, and good dispersal ability allow for connection of fragmented populations (Weaver et al. 1996). Highly adaptable populations also exhibit strong and quick responses to favourable environmental conditions. Less adaptable VCs will be more strongly influenced by human and natural disturbance than VCs with greater adaptive capacity.

A concept closely related to ecological adaptability is ecological resilience. Ecosystems and populations often have inertia and will continue to function after disturbance up to the point where the disturbance becomes severe enough that the system or population changes. Ecological resilience is the capacity of the system to absorb disturbance, and reorganize and retain the same structure, function, and feedback responses (Holling 1973; Gunderson 2000; Curtin and Parker 2014). Population resilience can be considered to share similar features as ecological resilience, with adaptability influencing the ability of the population to absorb or recover from change. Highly resilient VCs have the potential to recover quickly after disturbance (i.e., they are also adaptable), whereas VCs with narrower resilience limits will recover more slowly or may not recover at all.

Ideally, effect threshold values for adaptability and resilience limits of caribou would be known, and changes in measurement indicators can be quantified with a high degree of confidence to evaluate whether thresholds are expected to be exceeded. However, critical thresholds such as amount of quality habitat required to maintain a self-sustaining population or the specific number of individuals required for an ecologically effective population size are not available for caribou in this assessment.
Moreover, ecological thresholds vary by species, landscape type, and spatial scale (Fahrig 1997; Swift and Hannon 2010). Consequently, a detailed and transparent account of the predicted effects associated with incremental and cumulative changes to each measurement indicator are provided for caribou using available scientific literature, monitoring data collected from the North Slave region, logical reasoning, and experience of the practitioners completing the assessment (reasoned narrative approach).
Because of the uncertainty regarding the effects of development on caribou, magnitude classification was applied conservatively to avoid underestimating effects.

**Geographic Extent** – Geographic (spatial) extent refers to the area (or distance covered or range) of the effect, and is different from the spatial boundary (i.e., ESA) for the effects analysis. The study area for the effects analysis represents the maximum area used for the assessment and is related to the seasonal ranges of the caribou population (Section 6.3.1). However, the geographic extent of effects can occur on a number of scales within the spatial boundary of the assessment. Geographic extent is categorized into three scales of local, regional, and beyond regional.

Effects at the local scale are largely associated with the predicted maximum spatial extent of combined direct and indirect changes from a specific development or activity (e.g., cumulative effects that are specific to the Project). Effects at the regional scale occur within the effects study area, and are associated with incremental and cumulative changes from the Project and other developments.
The beyond regional scale includes cumulative residual effects from the Project and other developments that extend beyond the effects study area. The principle applied when using geographic extent to understand magnitude is that local effects from the Project are less severe than effects that extend to the regional or beyond regional scales, all other factors being equal.

**Duration** – Duration is defined as the amount of time (usually in years) from the beginning of a residual effect to when the residual effect on wildlife populations is reversed. Typically, duration is expressed relative to development phases. Both the duration of individual events and the overall time frame during which the residual effect may occur are considered. Some residual effects may be reversible soon after the effect has ceased, while other residual effects may take longer to be reversed. By definition, residual effects that are short-term, medium-term, or long-term in duration are reversible.

In certain cases, available scientific information and professional judgment may predict that the residual effect is irreversible. Alternately, the duration of the residual effect may not be known, except that it is expected to be extremely long and well beyond the temporal boundary of the Project. As such, any number of factors could cause wildlife populations to never return to a state that is unaffected by the Project. In other words, science and logic predict that the likelihood of reversibility is so low that the residual effect is irreversible.

#### *12.6.1.2 Determination of Significance*

The classification of primary pathways and the associated predicted changes in measurement indicators provide the foundation for determining the significance of incremental and cumulative effects from the Project and other existing, and reasonably foreseeable developments on the assessment endpoint for barren-ground caribou. The significance of the contribution of incremental effects from the Project on caribou is provided, but the evaluation is focused on determining the significance of cumulative effects on barren-ground caribou.

Magnitude is the primary criterion used to determine environmental significance, while other criteria are used as modifiers and to provide context when assigning magnitude. Geographic extent and duration provide important ecological context for classifying the magnitude of effects on a self-sustaining and ecologically effective caribou population. For example, determining the magnitude of an effect from changes in habitat availability and connectivity on caribou depends on the spatial extent (amount of area or proportion of the population) and duration of the changes in habitat (how long the population is adversely affected). Duration includes reversibility, and a reversible effect from development is one that does not result in a permanent adverse effect on population processes (e.g., survival and reproduction) and properties (e.g., stability and resilience). Frequency and likelihood are also considered as modifiers when determining significance, where applicable.

Duration is also a function of resilience, which is the ability of the population to recover or bounce back from a disturbance (e.g., rate and degree of fluctuation in population abundance and distribution after a disturbance). Resilience is largely a function of demographic and behavioural life history traits such as fecundity, age at reproduction, inter-birth interval, age-specific survival rates, lifespan of individuals, habitat selection, and seasonal ranges and migratory behaviour. The capacity or ability of individuals in a population to change and accommodate disturbance is also related to resilience. For example, certain wildlife species that avoid human features in relatively undisturbed landscapes can change their behaviour to accommodate disturbance where it is more prevalent (Martin et al. 2010; Knopff 2011). Other populations may be able to increase reproduction to compensate for harvest mortality.

Resilience can vary with population size, stability, and the likelihood of demographic rescue from neighbouring populations. During periods of low abundance, animal populations can become less resilient to natural environmental and human-related disturbances, which may reduce stability (i.e., trajectory of the population). Stable populations exhibit no long-term increasing or declining trend in abundance outside of natural fluctuations and cycles (e.g., predator-prey cycles). Resilience and stability are properties of a population that influence the amount of risk to caribou from development (Weaver et al. 1996). The duration of development-related effects may be shorter for VCs that are highly resilient and stable.

The evaluation of significance for barren-ground caribou considers the entire set of primary pathways that influence the assessment endpoint; thus, significance is not explicitly assigned to each pathway. Rather, the relative contribution of each pathway is used to determine the significance of the Project and other developments on the assessment endpoint, which represents a weight of evidence approach (i.e., evaluating the persuasiveness of evidence indicating that an effect is significant or not significant). For example, a pathway with a high magnitude, a large geographic extent, and a long-term duration is given more weight in determining significance relative to pathways with smaller scale effects. The relative effect from each pathway is discussed; however, pathways that are predicted to have the greatest influence on changes to the assessment endpoint are assumed to contribute the most to the determination of environmental significance.

In accordance with the Terms of Reference (MVRB 2014), for those environmental effects that are determined to be not significant a reasoned narrative is given that provides a potential qualitative significance threshold level. Key factors considered in the determination of environmental significance on caribou include the following:

- Results from the residual impact classification of primary pathways and associated predicted changes in measurement indicators (e.g., habitat loss, movement, survival, and reproduction).
- Magnitude is the primary criterion used to determine significance with geographic extent and duration providing important context for assigning magnitude. Frequency and likelihood act as modifiers for determining significance, where applicable.
- The level of confidence in predicted effects, scientific principles (e.g., resiliency and stability), and scientific interpretation are also included in the evaluation of determining environmental significance. Where uncertainty was high and the cumulative effect might be either significant or not significant, the assessment conservatively identified the effect as significant and provided additional follow-up actions to reduce uncertainty.

The following definitions are used for predicting the significance of effects on compliance with regulatory air emission guidelines and standards.

**Not significant** – impacts are measurable at the individual level, and strong enough to be detectable at the population level, but are not likely to decrease resilience and increase the risk to a self-sustaining and ecologically effective caribou population.

**Significant** – impacts are measurable at the population level, and are likely to decrease resilience and increase the risk to the maintenance of a self-sustaining and ecologically effective caribou population. Loss of habitat that causes permanent adverse changes to survival or reproduction at the population level would likely be significant. A significant effect may also result from habitat loss and fragmentation that reduces migratory or seasonal range movements to the point that it disrupts (breaks) population connectivity.

### 12.6.2 Results

The cumulative effects from the Project and other developments should not have a significant influence on the ability of the Bathurst caribou herd (and the Ahiak and Beverly herds) to be self-sustaining and ecologically effective. For all primary pathways influencing the abundance and distribution of the Bathurst herd, cumulative impacts were determined to be regional in geographic extent (Table 12.6-2), which implies that at least a portion of the population is affected during any given year, but likely not the entire population every year. The geographic extent of Project-specific effects ranged from local to regional. Local impacts from habitat loss and alteration were associated with the physical footprint and sensory disturbance from mining activities, and are predicted to influence individuals that travel through or occupy habitats within 5 km to 15 km from the Project site, depending on the type of infrastructure (road or mine facilities). Regional effects are a function of incremental and cumulative changes to caribou habitat, movement, and behaviour from Project-related traffic on the TCWR and human activities from other developments in annual range. The likelihood of impacts occurring is expected to be high for all pathways (Table 12.6-2), which does not change the expected magnitude and duration (or environmental significance). Similarly, the frequency of most impacts is anticipated to occur periodically or continuously throughout the life of the Project, depending on seasonal presence of caribou near the Project and other developments.

For the assessment of effects to caribou, physical disturbance to terrestrial habitat from developments was considered permanent (Table 12.6-2). Tundra ecosystems are slow to recover from disturbance, and it is uncertain as to what the revegetated landscape will look like in the future. The Ekati Mine ICRP works to facilitate and promote the natural colonization of disturbed areas. Early successional stages of planted vegetation may provide suitable forage for caribou.

The magnitude of effects from primary pathways on caribou ranged from low to moderate (Table 12.6-2). Direct habitat loss from the Project and previous, existing and approved developments (Application Case) varied among seasonal ranges, but the Project accounted for less than a 0.1% reduction in area for any habitat and season (and does not influence the winter range). Rock association (exposed bedrock or boulder fields with very little vegetative cover) is a preferred caribou habitat in the spring range, and was reduced by 5% in the Application Case. In other seasons, rock association is neither selected nor avoided by caribou (Johnson et al. 2005), and decreased by 15% in the post-calving range and by 16% in the autumn range. Eskers decreased by 0.8%, 1.3%, and 0.9% in spring, post-calving, and autumn ranges, respectively. Exposed rock was reduced by 0.6% in the winter season. Previous and existing developments and the Project decreased the area of all other habitats by less than 0.5% in each seasonal range. When reasonably foreseeable developments are added to the landscape, all habitats in all seasons show less than a 0.5% reduction in area from the Application Case to RFD Case. The cumulative direct disturbance from the Project and all previous, existing, and reasonably foreseeable future developments is predicted to be less than 0.6% of the total area in each seasonal range.

The effects of fragmentation on caribou across the seasonal ranges are expected to be low despite the conservative approach to the analyses that included overestimated footprint areas and irreversible effects from human disturbance features (Section 12.5). For all seasonal ranges, changes in fragmentation metrics from the reference condition to the RFD Case were less than 2.3%, with the exception of burns in the winter range (number of patches increased by 5%). Burns are not considered caribou habitat (Johnson et al. 2005) and fragmentation of burn patches should not affect winter range value for caribou.

Changes in the distance between similar habitats were less than 100 m for all seasonal ranges. Fragmentation effects have less influence than direct habitat loss when there is a large proportion of natural habitat on the landscape (Fahrig 1997, 2003; Andrén 1999; Flather and Bevers 2002; Swift and Hannon 2010), which is the expected state and condition of the Bathurst caribou range with the Project and previous, existing and future developments. Thus, caribou are predicted to be resilient to these small changes in physical habitat loss, and there should be no measurable effect on population abundance and distribution across the seasonal ranges.

Most of the effects of development on caribou within the seasonal ranges are related to modelled changes in habitat quality from the combined influences of sensory disturbance mechanisms (e.g., dust, noise, lights, viewscape, and general human activity). In the analysis of habitat quality, several conservative assumptions and conditions were applied to the models so that the predicted effects on caribou would not be underestimated (Section 12.5). The Project and previous, existing and approved developments were determined to reduce the amount of preferred habitat (includes physical footprints and zones of influence that decrease habitat quality) by 0.9% on the spring range (includes the calving grounds), 5.5% on the post-calving range, 6.1% on the autumn range, and 5.4% on the winter range. The proximity of the Project to existing Ekati Mine operations resulted in declines of preferred habitat from 0.0% to 0.2% among seasonal ranges. With the addition of uncertain, future developments (i.e., reasonably foreseeable) there was an increase in the loss of high quality habitat, particularly on the post-calving and autumn ranges. For the RFD Case, preferred habitat decreased by 1.7% in the spring range, 13.3% in the post-calving range, 12.0% in the autumn range, and 5.9% in the winter range.

Reductions in preferred habitats due to the zone of influence from development may result in an increase in the density of caribou where habitat is suitable and there are a lower number of developments (Cameron et al. 1992; Nellemann and Cameron 1998; Cameron et al. 2005; Fortin et al. 2013), particularly when the population is increasing and at high numbers. Higher density of caribou outside aggregated zones of influence may result in periodic overgrazing of some areas and attraction of predators. However, the cumulative effects from the zones of influence of previous, existing and approved human developments and the Project are not predicted to result in measurable shifts (e.g., east or west) or contractions in the distribution of caribou at the scale at which population processes operate (i.e., seasonal and annual ranges). Natural environmental factors that operate over large scales of space and time will likely have greater influences on seasonal distributions of caribou than the incremental and cumulative impacts from the Project and other developments. For example, studies of caribou have shown that the historical cumulative effect of overgrazing on calving, summer or winter ranges can result in periodic range shifts and large population fluctuations (Messier et al. 1988; Ferguson and Messier 2000; Tyler 2010). Climate change and weather can also influence the seasonal distribution of caribou by modifying insect levels, food abundance (primary productivity), timing of spring plant growth, snow depth and hardness, predator numbers (and alternative prey), and burns (Sharma et al. 2009; Vors and Boyce 2009; Festa-Bianchet et al. 2011; Kerby and Post 2013).

If climate change results in more frequent and severe fires on the winter range, forage availability may decrease and lead to declines in recruitment (Barrier and Johnson 2012). Inuit identified the increase in freezing rains in winter as an important factor limiting caribou access to food (Section 12.2.3.6; Banci et al. 2007). Traditional knowledge also contends that fire frequency and intensity affects caribou numbers and distribution (Kendrick et al. 2005), and behaviour (WKSS 2001a). Tłįchǫ Elders have reported changes to climate have decreased lichen availability as well as the timing and nature of caribou migration. They report southward migration later in the year and northward migration earlier in the spring, and a greater dispersal of caribou than in the past (Section 12.2.3.6). A recent analysis of collar data supports traditional knowledge and found a northern shift in the distribution or contraction of the core area of the Bathurst herd during the post-calving season (Golder 2014d).

The winter range of the Bathurst caribou herd is more likely than other seasonal ranges to be directly affected by large fires. Fires reduce the abundance of lichens, especially late-succession fruticose lichens that are the primary forage for caribou (Joly et al. 2007, 2009). The removal of lichens can last for decades (Holt et al. 2008; Jandt et al. 2008), and is thought to be the main reason why caribou avoid burned areas for long periods of time (up to 55 years) (WKSS 2001a; Joly et al. 2007). The number, frequency, size, and severity of fires is unpredictable and is likely to increase with climate change (Barrier and Johnson 2012; Gustine et al. 2014). As such, changes to the amount and quality of habitat in the winter range of the Bathurst caribou herd are difficult to predict. Adding to the unpredictability of effects is the knowledge that caribou have behavioural plasticity to shift seasonal ranges to adapt to changes in range conditions (Messier et al. 1988; Ferguson and Messier 2000; WKSS 2001a,b; Tyler 2010; Gustine et al. 2014).

The analysis of changes in caribou behaviour from sensory disturbance also included the use of an ecologically conservative and applicable energetic model to predict effects on calf production (Sections 12.4.2.3 and 12.5). Results indicated that encounters with development and insect harassment can have negative effects on adult female body condition in the autumn and reduce parturition rates the following spring. However, the key variable in the model is insect harassment. Even with the maximum previous, existing and future developments on the landscape (RFD Case), female caribou would have to increase their encounter rate with zones of influence by approximately 14 to19 times to result in no calf production the following spring. In contrast, when insect harassment is high, the predicted decline in parturition rate may be as large as 32%, with average insect harassment the decline in parturition is 16%, and with low insect harassment there is a 5% decline in calf production. Insect harassment, particularly oestrid flies, has been shown to have adverse effects on female body condition and calf production (Hagemoen and Reimers 2002; Weladji et al. 2003;Bergerud et al. 2008). In a recent study by Witter et al. (2012), Bathurst caribou spent more time walking than feeding when insect abundance was high, but feeding intensity (ratio of time eating to total time eating and searching) remained similar regardless of insect abundance. Feeding intensity appeared to be related more to seasonal changes in vegetation abundance (and likely quality) (Witter et al. 2012).

Changes in habitat quality from sensory disturbance associated with human developments are predicted to have a measurable effect on the abundance and distribution of caribou across the seasonal ranges. Effects on distribution (and local abundance) are expected to be detectable within 15 km of operating mine sites and 5 km of winter and all-season road corridors. Effects from sensory disturbance on habitat quality and calf production are anticipated to be reversible in the long term (perhaps 5 to 10 years following the end of closure of a project), and should be within the resilience limits and adaptive capacity of the Bathurst herd. When human activities are present, caribou are known to alter their behaviour to avoid disturbed landscapes. Initially, the response of caribou to roads is avoidance, but over time they can become habituated to the presence of roads and traffic (Haskell and Ballard 2008; ERM Rescan 2014a,b; Johnson and Russell 2014).

Deflections in animal movement from increased traffic on the Misery and Jay roads could adversely affect migration and connectivity of the Bathurst caribou herd. The expansion of the Ekati Mine monitoring program during migration periods will identify concentrations and movements of animals that may interact with the roads. Stockpiling of ore, modifications to traffic patterns, and the implementation of road closures are expected to provide opportunities for caribou to move across the roads, and limit effects to migration and maintain population connectivity. Qualitative analysis predicted that the presence of the power lines should result in negligible changes to caribou movements and distribution relative to increased traffic on the Misery and Jay roads (Section 12.4.2.2.2).

Elders from communities have expressed concerns about mining developments affecting the timing and routes of caribou migration. Although future development is uncertain, the Izok Corridor and Bathurst Inlet Port and Road are reasonably foreseeable projects (Section 6.5.2.4) that could affect caribou abundance, distribution, and population connectivity by increasing habitat loss and fragmentation, and decreasing habitat quality and calf production. The Izok Corridor and Bathurst Inlet Port and Road may act as barriers to animal movement within the northern portion of the Bathurst caribou range. If developed, these all-season roads will be within the spring, post-calving, and autumn ranges of the herd, and on or encroaching the calving grounds. To provide some understanding of the potential degree of interaction between caribou and these future projects Bathurst collar data from 1996 to 2013 were used to forecast the encounter rate of animals with the hypothetical zones of influence of the Izok Corridor and Bathurst Inlet Port and Road. The analysis was completed for the spring (April 15 to June 14, n = 272 paths), post-calving (June 15 to August 31, n = 248 paths) and autumn (September 1 to October 31, n = 232 paths) ranges. The number of times per year that collared caribou encountered the zones of influence for Izok Corridor and Bathurst Inlet Port and Road ranged from 0.0 to 0.03 per 61 days in the spring range, 0.01 to 0.07 per 78 days in the post-calving range, and 0.0 to 1.3 per 60 days in the autumn range. The uncertainty in applying these values to the future abundance and movements of the entire herd is acknowledged, but the estimates suggest a low frequency of caribou interaction with the Izok Corridor and Bathurst Inlet Port and Road. If these projects are developed, then it is anticipated that temporary modifications to traffic patterns and road closures would be implemented to mitigate effects to migratory movements and population connectivity.

The Hydroelectric Grid Expansion also is an uncertain, future project that proposes to connect the existing Snare and Taltson grids using a 240 kV transmission line around the west side of Great Slave Lake and expanding the grid to service the diamond mines ( Section 6.5.2.4). Expansion of the hydroelectric grid could change caribou habitat use and distribution if animals avoid or restrict movements near the transmission lines (Vistnes and Nellman 2008; Vistnes et al. 2008; Tyler et al. 2014).

For cumulative effects of development to have a significant influence on self-sustaining and ecologically effective caribou populations there would have to be sufficient changes that the populations would no longer be resilient or have the ability to adapt to natural selection pressures (e.g., weather, insects, and predation). In terms of the measurement indicators used in this assessment (e.g., habitat quantity and quality, movement and behaviour, and survival and reproduction) this might include permanent removal of preferred habitat or highly productive areas important for survival and reproduction at the population level. Because migration between the winter and calving grounds is a critical life history strategy of barren-ground caribou (Gunn 2009), a long-term or irreversible adverse change in access to biologically important areas of the seasonal ranges may have a significant effect on the ability of the population to be self-sustaining. Similarly, large-scale changes in movement and distribution that disrupt population connectivity would likely be significant. For example, an abrupt change in abundance from dividing a caribou herd could decrease the effectiveness of predator swamping or lead to inbreeding depression or random fluctuations in sex ratio, which can have large effects on small populations (all of which are termed Allee effects [Vors and Boyce 2009; Swift and Hannon 2010). Significant cumulative effects from development may also result from long-term or permanent depression in caribou abundance where the population is still self-sustaining but no longer supports ecosystem functions such as nutrient cycling through grazing and deposition of fecal nitrogen (see Vors and Boyce 2009), and stable wolf, grizzly bear and wolverine populations.

Barren-ground caribou populations have natural cycles of high and low numbers, and their distributions change through time (Adamczewski et al. 2009; Tłįchǫ Government and ENR 2010; Tyler 2010; Festa-Bianchet et al. 2011). Resilience in caribou herds likely fluctuates with population size so that the ability to recover from natural and human disturbances is greater when caribou are increasing and at high numbers (Bergerud et al. 2008; Gunn 2009). Although estimates are uncertain, a 2014 reconnaissance survey suggests a large decline in the Bathurst herd since 2012 (Boulanger et al. 2014b). A GNWT photo survey planned for the summer of 2015 will provide more precise estimates of size and trend for the herd. Boulanger et al. (2011, 2014a) noted that the demographic trends observed up to 2012 could be explained by reduced recruitment and a constant harvest rate; recovery from the low point in the cycle was thought to be dependent on high calf survival rates and low harvest rates for breeding females. Boulanger et al. (2014b) did not provide a similar interpretation for the 2014 survey results.

Overall, the weight of evidence from the analysis of the primary pathways predicts that incremental and cumulative changes to measurement indicators from the Project and other developments should have no significant adverse effect on self-sustaining and ecologically effective barren-ground caribou populations. The confidence in this prediction is higher for the Application Case than the RFD Case. Data collected over the past 15 to 18 years from government and academic research studies and monitoring programs on the Bathurst herd provide certainty in the model inputs and assumptions that were used to estimate the changes in caribou habitat, behaviour, movement and energetics from the Project and previous, existing and approved developments (i.e., Application Case). Adamczewski et al. (2009) indicated that effects from the previous and existing mines are limited and unlikely a major contributing factor in the recent decline of the Bathurst caribou herd.

Extending the assessment into the future (RFD Case) decreases confidence in effects predictions, which is largely due the uncertainty in the actual timing (e.g., amount of overlap in time with the Project and existing developments), location and size of developments, and the variability inherent in making long-term predictions in ecological systems. The present structure and inputs of habitat and energetic models may not be applicable to future environments and caribou behavioural responses and population characteristics, which increases the uncertainty in cumulative effects from physical habitat loss and sensory disturbance on caribou abundance and distribution. Still, confidence in the predictions for the RFD Case is based on the consistent low effect sizes (i.e., magnitudes of change) that were determined from the incremental and cumulative changes from the Project and other developments for habitat quantity and habitat quality, and energetics. Although each development likely influences the local movement and distribution of caribou across their seasonal ranges, there is no strong mechanism causing an adverse and long-term or permanent change in population survival and reproduction rates. The implementation of temporary modifications to traffic patterns and road closures is predicted to mitigate effects to migration and maintain connectivity for self-sustaining and ecologically effective barren-ground caribou populations.

**Table 12.6-2 Summary of Residual Impact Classification of Primary Pathways and Predicted Significance of Cumulative Effects on Caribou**

| Pathway | Magnitude | Geographic Extent | Duration | Frequency | Reversibility | Likelihood | Significance for Assessment Endpoint[a] |
|---|---|---|---|---|---|---|---|
| Direct loss and fragmentation of caribou habitat from the Project footprint causes changes in caribou abundance and distribution | Low | Regional | Permanent | Continuous | Irreversible | Highly likely | Not significant |
| Sensory disturbance (lights, smells, noise, dust, viewscape) and barriers to movement causes changes to caribou distribution and behaviour, and changes to energetics and reproduction | Moderate | Regional | Long-term | Continuous | Reversible | Highly likely | |
| Increased traffic on the Misery Road and Jay Road, and the above-ground power line along these roads may create barriers to caribou movement, change migration routes, and reduce population connectivity | Moderate | Regional | Long-term | Periodic | Reversible | Highly Likely | |

a) Self-sustaining and ecologically effective caribou populations.

## 12.7 Follow-Up and Monitoring

In the DAR, monitoring programs are proposed to deal with the uncertainties associated with the effect predictions and the performance of environmental design features and mitigation. In general, monitoring is used to verify the effects predictions. Monitoring also is used to identify any unanticipated effects and provide for the implementation of adaptive management to limit these effects. Typically, monitoring includes one or more of the following categories, which may be applied during the development of the Project:

- **Compliance monitoring** – monitoring activities, procedures, and programs undertaken to confirm the implementation of approved design standards, mitigation, and conditions of approval and company commitments (e.g., inspecting the installation of a silt fence, monitoring of mine water discharge quality and volumes).
- **Follow-up monitoring** – programs designed to test the accuracy of effects predictions, reduce/address uncertainties, determine the effectiveness of environmental design features, and/or provide appropriate feedback to operations for modifying or adopting new mitigation designs, policies, and practices (e.g., monitoring of downstream lakes for aquatic effects, wildlife effects monitoring, and socio-economic monitoring). Results from these programs can be used to increase the certainty of effect predictions in future environmental assessments.

These programs form part of the environmental management system for the Project. If monitoring or follow-up detects effects that are different from predicted effects, or the need for improved or modified design features and mitigation, then adaptive management will be implemented. This may include increased monitoring, changes in monitoring plans, or additional mitigation.

Monitoring activities for barren-ground caribou currently are within the scope of the Ekati Mine WEMP (ERM Rescan 2014b) and will be applied to the Project (including construction, operations, and closure). The existing Ekati Mine WEMP is consistent with wildlife and wildlife habitat monitoring guidelines prepared by the GNWT (GNWT-ENR 2013). Wildlife monitoring completed as part of the existing Ekati Mine WEMP includes measuring habitat loss, mine-related wildlife mortalities and interactions with site (including roads), mitigation and waste management effectiveness, and changes to behaviour (ERM Rescan 2014b). Caribou are included in these programs. The Ekati Mine WEMP is designed to:

- test impact predictions;
- evaluate mitigation effectiveness; and,
- provide evidence for adaptive management.

As part of compliance monitoring at the Ekati Mine, caribou behaviour monitoring to determine the type and magnitude of caribou responses to the presence and operation of the Ekati Mine is completed annually (ERM Rescan 2014b). Additional caribou monitoring programs currently in place at the Ekati Mine include monitoring caribou activity in the LLCF and monitoring caribou activity near the mine. In addition to mine-related effects monitoring programs, Dominion Diamond has participated or contributed to regional wildlife monitoring initiatives intended for conservation and management including the GNWT's Barren-ground Caribou Management Strategy (GNWT-ENR 2011) and the Bathurst Range Plan Working Group. One initiative that is supported in part by Dominion Diamond is the Bathurst caribou aerial surveys used to determine herd composition, cow:calf ratios, and population estimates. Dominion Diamond is also involved in the Zone of Influence Working Group, which is tasked with determining the most effective methods for future monitoring of caribou distribution near mine sites. These programs provide data to support cumulative effects assessment and management by the GNWT.

There is uncertainty regarding the magnitude of effects on caribou migration and movement from increased traffic on the Misery and Jay roads. Dominion Diamond will implement monitoring of the Bathurst caribou herd to track migratory movements with the use of (i) satellite radiocollars (i.e., data requested from GNWT), (ii) reconnaissance surveys near the roads, and (iii) road surveys. The data collected during these monitoring activities will be used to test effects predictions and the success of proposed mitigation to limit effects to caribou from increased traffic on the roads.

## 12.8 References

Adamczewski JZ, Boulanger J, Croft B, Cluff D, Elkin B, Nishi J, Kelly A, D'Hont A, Nicholson C. 2009. Decline of the Bathurst Caribou Herd 2006-2009: A technical evaluation of field data and modeling. Draft technical report December 2009. GNWT.

Adamczewski JZ, Gates CC, Hudson RJ, Price MA. 1987. Seasonal Changes in Body Composition of Mature Female Caribou and Calves (Rangifer tarandus groenlandicus) on an Arctic Island with Limited Winter Resources. Can J Zoolog, 65:1149-1157.

Andrén H. 1999. Habitat Fragmentation, the Random Sample Hypothesis, and Critical Thresholds. Oikos 84(2): 306-308.

APLIC (Avian Power Line Interaction Committee). 2012. Reducing Avian Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute and APLIC, Washington DC, USA.

Auerbach NA, Walker MD, Walker DA. 1997. Effects of roadside disturbance on substrate and vegetation properties in Arctic tundra. Ecol Appl 7: 218-235.

Avgar T, Mosser A, Brown BS, Fryxell JM. 2012. Environmental and individual drivers of animal movement across a wide geographical gradient. J Anim Ecol 82:96-106.

Banci V, Hanak J, Ovilok J, Engoaloak H. 2007. Caribou and Roads: Implementing Traditional Knowledge in Wildlife Monitoring at the Ekati Diamond Mine 2006 Annual Report. Yellowknife, NWT, Canada.

Banci V, Hanks C, Spicker R, Atatahak G. 2006. Walking in the Path of the Caribou: Knowledge of the Copper Inuit, Naonaiyaotit Traditional Knowledge Project Report Series, Vol. I Pitkohit: Heritage and Culture. Kitikmeot Inuit Association, Cambridge Bay and Kugluktuk, NU, Canada.

Barrier TA, Johnson CJ. 2012. The Influence of Fire History on Selection of Foraging Sites by Barren-Ground Caribou. Ecoscience 19: 177-188.

Barrier TA, Johnson CJ. 2012. The influence of fire history on selection of foraging sites by barren-ground caribou. Ecoscience 19: 177-188.

Beckmann JP, Lackey CW. 2008. Carnivores, Urban Landscapes, and Longitudinal Studies: a Case History of Black Bears. Human-Wildlife Conflicts 2: 168-174.

Benitez-Lopez A, Alkemade R, Verweij PA. 2010. The impacts of roads and other infrastructure on mammal and bird populations: A meta-analysis. Biol Conserv 143:1307-1316.

Benn B, Herrero S. 2002. Grizzly bear mortality and human access in Banff and Yoho National Parks, 1971-98. Ursus 13:213-221.

Berger R, Martinez I, Wisener M. 2000. Analysis of GPS Relocation Data (1995-1999) for the Owl Lake Woodland Caribou – Report to Manitoba Hydro, Manitoba Conservation, Pine Falls Paper Company, Manitoba Model Forest and Time to Respect Earth's Ecosystems. 88 pp + appendices.

Bergerud AT, Jakimchuk RD, Carruthers DR. 1984. The Buffalo of the North: Caribou (*Rangifer tarandus*) and Human Developments. Arctic 37:7-22.

Bergerud AT, Luttich SN, Camps L. 2008. The Return of Caribou to Ungava. McGill-Queen's University Press, Montreal, QC, Canada.

BHP (Broken Hill Proprietary Company). 1995. NWT Diamonds Project. Volume I: Project Description.

BHP Billiton (BHP Billiton Canada Inc). 2001. Ekati Diamond Mine 2000 Wildlife Effects Monitoring Program. Prepared by Rescan Environmental Services Ltd.

BHP Billiton. 2002. Ekati Diamond Mine 2001 Wildlife Effects Monitoring Program. Prepared by Rescan Environmental Services Ltd.

BHP Billiton. 2003. 2002 Wildlife Effects Monitoring Program. Prepared by Golder Associates Ltd. January, 2003.

BHP Billiton. 2004. Ekati Diamond Mine 2003 Wildlife Effects Monitoring Program. Prepared by Golder Associates Ltd. Yellowknife, NWT, Canada.

BHP Billiton. 2011. 2011 WEMP Kugluktuk Community Engagement Program June 1-8, 2011. 31pp.

BHP (Broken Hill Proprietary Company). 1999. Ekati Diamond Mine 1999 Wildlife Effects Monitoring Program. Prepared by Rescan Environmental Services Ltd. December 1999.

Bladon, KD, Emelko MB, Silins U, and Stone M. 2014. Wildfire and the Future of Water Supply. Environmental Science and Technology 48: 8936-8943

Blaxter KL. 1962. The energy metabolism of ruminants. C. C. Thomas, Springfield, Illinois.

Boertje RD. 1985. An Energy Model for Adult Female Caribou of the Denali Herd, Alaska. Jf Range Manage 38: 468-173.

Boulanger J, Croft B, Adamczewski J. 2014a. An Estimate of Breeding Females and Analyses of Demographics For The Bathurst Herd of Barren-ground Caribou: 2012 Calving Ground Photographic Survey. Integrated Ecological Research Unpublished File Report No. 142 for Environment and Natural Resources, GNWT. 81 pp.

Boulanger J, Croft B, Cluff D. 2014b. Trends in size of the Bathurst caribou herd from the 2014 calving ground reconnaissance survey. Integrated Ecological Research. July 31, 2014.

Boulanger J, Gunn A, Adamczewski J, Croft B. 2011. A Data-Driven Demographic Model to Explore the Decline of the Bathurst Caribou Herd. J Wildlife Manage 75: 883-896.

Boulanger J, Gunn A. 2007. Exploring Possible Mechanisms for the Decline of the Bathurst Herd of Barren-Ground Caribou Using Demographic Modeling. Manuscript 175. Department of Environment and Natural Resources, GNWT. 66 pp.

Boulanger J, Poole K, Fournier B, Wierzchowski J, Gaines T, Gunn A. 2004. Assessment of Bathurst Caribou Movements and Distribution in the Slave Geological Province. GNWT Manuscript Report 158.

Boulanger J, Poole KG, Gunn A, Wierzchowski J. 2009. The Zone of Influence for Migratory Tundra Caribou around Canada's Arctic Diamond Mines: Estimation and Implications. Unpublished report.

Boulanger J, Poole KG, Gunn A, Wierzchowski J. 2012. Estimating the Zone of Influence of Industrial Developments on Wildlife: a Migratory Caribou Rangifer tarandus groenlandicus and diamond mine case study. Wildlife Biol 18: 164-179.

BQCMB (Beverly and Qamanirjuaq Conservation Management Board). 2008. Facts Point to Major Decline in Beverly herd. Available at: http://www.arctic-caribou.com/news_winter08-09.html#facts. November 30, 2013.

BQCMB. 2009. Shrinking Beverly Herd Goes from Bad to Worse. Available at: http://www.arctic-caribou.com/news_summer2009.html#SHRINKING. Accessed: November 30, 2013.

Bradshaw CJA, Boutin S, Hebert DM. 1998. Energetic implications of disturbance caused by petroleum exploration to woodland caribou. Can J Zoolog-Can J Zool 76:1319-1324.

Burgman MA, Lindenmayer DB, Elith J. 2005. Managing landscapes for conservation under uncertainty. Ecology 86:2007-2017.

Cameron RD Reed DJ, Dau JR, Smith WT. 1992. *Redistribution of Calving Caribou in Response to Oil Field Development on the Arctic Slope of Alaska.* Arctic 45:338-342.

Cameron RD, Smith WT, Fancy SG, Gerhart KL, White RG. 1993. Calving success of female caribou in relation to body weight. Can J Zoolog, 71:480-486.

Cameron RD, Smith WT, White RG, Griffith B. 2005. Central Arctic caribou and petroleum development: distributional, nutritional, and reproductive implications. Arctic 58:1-9.

Cameron RD, Ver Hoef JM. 1994. Predicting parturition rate of caribou from autumn body mass. J Wildlife Manage 58:674-679.

Canadian Wildlife Service. 2007. Preventing Wildlife Attraction to Northern Industrial Sites. Environment Canada. 30 p.

Case R, Buckland L, Williams M. 1996. The Status and Management of the Bathurst Caribou Herd, Northwest Territories, Canada. GNWT File Report 116:34-34.

Core JE and Peterson JL. 2001. Chapter 3.1 Public Health Effects *in* Hardy CC, Ottmar RD, Peterson JL, Core JE, and Seamon P (eds) Smoke Management Guide for Prescribed and Wildland Fire 2001 Edition. National Wildfire Coordinating Group Fire Use Working Team. 236 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2013. Wildlife Species Search. Available at: http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm. Accessed: November 1, 2013.

Croft B, Johnson C, Barrier T. 2009. Final report: monitoring and understanding movement and distribution of Bathurst caribou. NWT Cumulative Impact monitoring Program: Capacity Building and Monitoring Projects 2007-2008.

Curatolo JA. 1975. Factors Influencing Local Movements and Behaviour of Barren-Ground Caribou (*Rangifer tarandus granti*). Master of Science Thesis. University of Alaska, Fairbanks, AK, USA.

Curtin CG, Parker JP. 2014. Foundations of resilience thinking. Cons Biol 28: 912-923.

Dale BW, Adams LG, Collins WB, Jolly K, Valkenburg JP, Tobey R. 2008. Stochastic and compensatory effects limit persistence of variation in body mass of young caribou. J Mammal 89:1130-1135.

DCI (Dene Cultural Institute). 1995. Tłı̨chǫ Ndè: The Importance of Knowing, Dene Cultural Institute for the Dogrib Treaty 11 Council and BHP Diamonds, Appendix 1-A1 in NWT Diamonds Project: Environmental Impact Statement Project Description, Volume I, Behchokǫ̀, NWT, Canada.

DDMI (Diavik Diamond Mines Inc.). 1998. Wildlife Baseline Report, Diavik Diamonds Project, Lac de Gras, NWT. Prepared by Penner and Associates Ltd.

DDMI. 2003. 2002 Wildlife Monitoring Report. March 2003.

DDMI. 2004. 2003 Wildlife Monitoring Report. March 2004.

DDMI. 2005. 2004 Wildlife Monitoring Report. March 2005.

DDMI. 2006. 2005 Wildlife Monitoring Report. March 2006.

DDMI. 2007. 2006 Wildlife Monitoring Report. March 2007.

DDMI. 2008. 2007 Wildlife Monitoring Report. April 2008.

DDMI. 2009. 2008 Wildlife Monitoring Program Report. April 2009.

DDMI. 2010. 2009 Wildlife Monitoring Program. April 2010.

DDMI. 2011. 2010 Wildlife Monitoring Report. March 2011.

DDMI. 2012. Wildlife Monitoring Program Report – 2011. March 2012.

DDMI. 2013. 2012 Wildlife Monitoring Program Report. March 2013.

De Beers (De Beers Canada Inc.). 2002. Snap Lake Diamond Project Environmental Assessment Report. Prepared for De Beers Canada Mining Inc. by Golder Associates Ltd. Yellowknife, NWT, Canada.

De Beers. 2004. Snap Lake Diamond Project Wildlife Effects Monitoring Program. July 2004.

De Beers. 2010. Gahcho Kué Project Environmental Impact Statement. Prepared by Golder Associates Ltd.

De Beers. 2012. Gahcho Kué Project. Environmental Impact Statement. Annex P – Wildlife Ecological Risk Assessment. October 2012.

De Beers. 2013. De Beers Snap Lake Mine: Analysis of Environmental Effects on Wildlife, 1999 to 2012. Prepared by Golder Associates Ltd. March 2013.

De Beers. 2014. *Wildlife and Wildlife Habitat Protection Plan. Gahcho Kué Project.* Submitted to the Mackenzie Valley Land and Water Board. Yellowknife, NWT. May 2014.

Dezé (Dezé Energy Corporation Ltd.). 2009. Taltson Hydroelectric Expansion Project Developer's Assessment Report. Dezé Energy, Yellowknife, NWT, Canada.

DKFN (Deninu K'ue First Nation). 2012. Deninu K'ue Ethno-History Report. December 12, 2012.

Dominion Diamond (Dominion Diamond Ekati Corporation). 2013. Appendix A. 2013 Community Vegetation Workshop Summary. Dominion Diamond Ekati Corporation, Yellowknife, NWT, Canada.

Dragon JID. 2002. Commercial Use of Caribou (*Rangifer tarandus*) in the Canadian Arctic. Ph.D. Thesis. Department of Renewable Resources, University of Alberta, Edmonton, AB, Canada.

DTC (Dogrib Treaty 11 Council). 2001. Caribou Migration and the State of Their Habitat. Final Report to West Kitikmeot Slave Study Society. Yellowknife, NWT, Canada.

Dyer SJ, O'Neill JP, Wasel SM, Boutin S. 2002. Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta. Can J Zoolog 80:839-845.

EBA (EBA Engineering Consultants Ltd.). 2001. Tibbitt to Contwoyto Winter Road Environmental Setting Report. Prepared by EBA Engineering Consultants for the Tibbitt to Contwoyto Winter Road Joint Venture, Yellowknife, NWT, September 2001.

Ecosystem Classification Working Group. 2012. Ecological Regions of the Northwest Territories: Southern Arctic. Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NWT, Canada. x + 170 p. + insert map.

ENR (Department of Environment and Natural Resources). 2tcwr009. Seasonal satellite movement maps for collared Bathurst caribou 2001. Available at: www.nwtwildlife.com/NWTWildlife/caribou/satellite2.htm. Accessed: March 27, 2009.

ENR. 2011. Tibbitt Lake to Contwoyto Winter Road Monitoring Station Report. July 13, 2011. North Slave Region, Environment & Natural Resources.

ENR. 2014. Northwest Territories Summary of Hunting Regulations. July 1, 2014 to June 30, 2015.

Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. Environment Canada, Ottawa, Ontario. 252 pp.

ERM Rescan (ERM Rescan Environmental Services Ltd.). 2013a. Ekati Diamond Mine 2012 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

ERM Rescan. 2013b. Ekati Diamond Mine 2012 WEMP Addendum Wildlife Camera Monitoring Summary Report. May 2013. Yellowknife, NWT, Canada.

ERM Rescan. 2014a. Ekati Diamond Mine: 2013 WEMP Addendum Wildlife Camera Monitoring Summary Report. Prepared for Dominion Diamond Ekati Corporation by ERM Rescan, Yellowknife, NWT, Canada.

ERM Rescan. 2014b. Ekati Diamond Mine: 2013 Wildlife Effects Monitoring Program. Prepared for Dominion Diamond Ekati Corporation. March 2014.

Fahrig L. 1997. Relative effects of habitat loss and fragmentation on population extinction. J Wildlife Manage 61(3): 603-610.

Fahrig L. 2003. Effects of habitat fragmentation on biodiversity. Ann Rev Ecol Evol Systematics 34:487-515.

Farmer AM. 1993. The effects of dust on vegetation – a review. Environ Pollut 79:63-75.

Festa-Bianchet M, Ray JC, Boutin S, Côté SD, Gunn A. 2011. Conservation of caribou (*Rangifer tarandus*) in Canada: an uncertain future. Can. J. Zool. 89:419-434.

Ferguson MAD, Messier F. 2000. Mass emigration of Arctic tundra caribou from a traditional winter range: population dynamics and physical condition. J Wildlife Manage 64:168-178.

Fisher JT, Roy LD, Hiltz M. 2009. Barren-Ground Caribou Management in the Northwest Territories: An Independent Peer Review. Alberta Research Council, Sustainable Ecosystems Unit, Ecological Conservation Management Program. Vegreville, AB, Canada. 53 p.

Flannigan MD, Logan KA, Amiro BD, Skinner WR, and Stocks BJ. 2005. Future Area Burned in Canada. Climate Change 72: 1-16.

Flather CH, Bevers M. 2002. Patchy reaction-diffusion and population abundance: the relative importance of habitat amount and arrangement. The American Naturalist 159:40-56.

Fortin D, Buono P-L, Fortin A, Courbin N, Gingras CT, Moorcroft PR, Courtois R, Dussault C. 2013. Movement responses of caribou to human-induced habitat edges lead to their aggregation near anthropogenic features. The American Naturalist 181:827-836.

Flydal K, Korslund L, Reimers E, Johansen F, Colman JE. 2009. Effects of power lines on area use and behaviour of semi-domestic reindeer in enclosures. Int J Ecol: 2009.

Flydal K, Rogstad I, Per E, Reimers E. 2003. Reindeer (Rangifer tarandus tarandus) Perception of noise from powerlines. Rangifer 23:21-24.

Fortune (Fortune Minerals Ltd.). 2011. NICO Developer's Assessment Report. Prepared by Golder Associates Ltd.

Gerhart KL, Russell DE, Van De Wetering D, White RG, Cameron RD. 1997. Pregnancy of Adult Caribou (Rangifer tarandus): Evidence for lactational infertility. J Zoolog 242:17-30.

GNWT (Government of the Northwest Territories). 2012. Update on NWT barren-ground caribou. News release from November 6, 2012. http://news.exec.gov.nt.ca/update-on-nwt-barren-ground-caribou/

GNWT. 2013a. New population estimates for the Beverly and Ahiak subpopulations. Available at: http://news.exec.gov.nt.ca/new-population-estimates-for-the-beverly-and-ahiak-caribou-subpopulations/. Accessed: September 16, 2014.

GNWT. 2013b. Limited Resident Barren-Ground Caribou and Bison Harvest Approved. News release from December 9, 2013. http://news.exec.gov.nt.ca/limited-resident-barren-ground-caribou-and-bison-harvest-approved/

GNWT-ENR (Environment and Natural Resources, Government of the Northwest Territories). 2011. Caribou Forever – Our Heritage, Our Responsibility: A Barren-Ground Caribou Management Strategy for the Northwest Territories 2011-2015. Yellowknife, NWT, Canada. 56 pp.

GNWT-ENR. 2013. NWT Barren-Ground Caribou (*Rangifer tarandus groenlandicus*). Available at: http://www.enr.gov.nt.ca/_live/pages/wpPages/caribou_information.aspx. Accessed: January 23, 2014.

GNWT-ENR. 2014. Guideline for Ambient Air Quality Standards in the Northwest Territories. Available at: http://www.enr.gov.nt.ca/sites/default/files/guidelines/air_quality_standards_guideline.pdf. Accessed: August 14, 2014.

Golder (Golder Associates Ltd). 2003. Report on Baseline and Interim Wildlife Monitoring Snap Lake Diamond Project 2002. Prepared by Golder Associates Ltd. for De Beers Canada Mining Inc. Yellowknife, NWT, Canada.

Golder. 2006. Snap Lake Project Wildlife Effects Monitoring Program 2005 Annual Report. Prepared for De Beers Canada Inc. Yellowknife, NWT, Canada.

Golder. 2007. Snap Lake Project Wildlife Effects Monitoring Program 2006 Annual Report. Prepared for De Beers Canada Inc. Yellowknife, NWT, Canada.

Golder. 2008a. Snap Lake Mine: Analysis of Environmental Effects on Wildlife 1999 to 2007. Prepared by Golder Associates Ltd. for De Beers Canada Ltd, Yellowknife, NWT, Canada.

Golder. 2008b. Analysis of Environmental Effects from the Diavik Diamond Mine on Wildlife in the Lac de Gras Region. Submitted to Diavik Diamond Mines Inc., Yellowknife, NWT, Canada.

Golder. 2010. Snap Lake Project Wildlife Effects Monitoring Program 2010 Annual Report. Prepared for De Beers Canada Inc. Yellowknife, NWT, Canada.

Golder. 2011a. Analysis of Environmental Effects from the Diavik Diamond Mine on Wildlife in the Lac de Gras Region. Prepared for Diavik Diamond Mines Inc., Yellowknife, NWT.

Golder. 2011b. Risk Assessment of Caribou Exposure to Metals from Dust Deposition on Lichen. Prepared for Diavik Diamond Mines Inc., NWT, Canada.

Golder. 2012. De Beers Snap Lake Mine Wildlife Effects Monitoring Proram 2011 Annual Report.

Golder. 2013. De Beers Snap Lake Mine Analysis of Environmental Effects on Wildlife, 1999 to 2012. Submitted to De Beers Canada Inc. March 2013.

Golder. 2014a. 2013 Wildlife Monitoring Report. Prepared for Diavik Diamond Mines (2012) Inc. Yellowknife, NWT, Canada.

Golder. 2014b. De Beers Snap Lake Mine Wildlife and Wildlife Habitat Protection Plan 2013 Annual Report. Yellowknife, NWT, Canada.

Golder. 2014c. 2013 Comprehensive Vegetation and Lichen Monitoring Program. Prepared for Diavik Diamond Mines (2012) Inc. Yellowknife, NWT, Canada.

Golder. 2014d. Analysis of Environmental Effects from the Diavik Diamond Mine on Wildlife in the Lac de Gras Region. Prepared for Diavik Diamond Mines (2012) Inc Yellowknife, NWT.

Griffith B, Douglas DC, Walsh NE, Young DD, McCabe TR, Russell DE, White RG, Cameron RD, Whitten KR. 2002. The Porcupine caribou herd. In: Arctic Refuge coastal plain terrestrial wildlife research summaries. Available at: http://alaska.usgs.gov/BSR-2002/index.html. Accessed: August 21, 2014.

Gunderson LH. 2000. Ecological resilience – in theory and application. Ann Revi Ecol Systematics 31:425-439.

Gunn A, Dragon J, Boulanger J. 2001. Seasonal movements of satellite-collared caribou from the Bathurst herd. Final Report to the West Kitikmeot Slave Study Society, Yellowknife, NWT.80pp.

Gunn A, Miller F, Nishi J. 1998. Status of Endangered and Threatened Caribou on Canada's Arctic Islands. Abstract. Eighth North American Caribou Conference, Whitehorse, YK, Canada, March 1998.

Gunn A. 2009. Facing a future of change: wild migratory caribou and reindeer. Arctic 62: iii-vi.

Gustine DD, Brinkman TJ, Lindgren MA, Schmidt JI, Rupp TS, Adams LG. 2014. Climate-Driven Effects of Fire on Winter Habitat for Caribou in the Alaska-Yukon Arctic. PLOS One 9: e100588.

Hagemoen RIM, Reimers E. 2002. Reindeer Summer Activity Pattern in Relation to Weather and Insect Harassment. J Anim Ecol 71:883-892.

Harper M. 2014. Lines Designer, McGregor Construction 2000 Ltd. Calgary, AB, Canada. E-mail. July 8, 2014.

Haskell SP, Ballard WB. 2008. Annual re-habituation of calving caribou to oilfields in northern Alaska: implications for expanding development. Can J Zoolog 86:627-637.

Hearne S. 1795. A Journey from Prince of Wales Fort in Hudson's Bay, to the Northern Ocean. Undertaken by order of the Hudson's Bay Company, for the Discovery of Copper Mines, a North West Passage, & in the Years 1769, 1770, 1771, & 1772. Strahan A, Cadell T (Eds). London, England.

Helle T, Tarvainen L. 1984. Effects of Insect Harassment on Weight Gain and Survival in Reindeer (Rangifer tarandus) Calves. Rangifer, 4:24-27.

Hogg C, Neveu M, Stokkan K-A, Folkow L, Cottrill P, Douglas R, Hunt DM, Jeffrey G. 2014. Arctic reindeer extend their visual range into the ultraviolet. J Exp Biol 214: 2017-2019.

Holling CS. 1973. Resilience and stability of ecological systems. Ann Rev Ecol Systematics 4:1-23.

Holt EA, McCune B, Neitlich P. 2008. Grazing and Fire Impacts on Macrolichen Communities of the Seward Peninsula, Alaska, USA. The Bryologist 111: 68-83.

Hugron S, Andersen R, Poulin M, Rochefort L. 2011. Natural plant colonization of borrow pits in boreal forest highlands of eastern Canada. Botany 89:451-465.

IEMA (Independent Environmental Monitoring Agency). 2011. Summary of Discussion from the Annual General Meeting of the Society of the Independent Environmental Monitoring Agency. Independent Environmental Monitoring Agency, Yellowknife, NWT, Canada.

Jacobsen P. 2011. Tłįchǫ Elders' Knowledge of Climate Change and Forest Fires: Implications for Barren-Ground Caribou Hunting. University of Northern British Columbia, Prince George, BC, Canada.

Jandt RR, Joly K, Meyers CR, Racine C. 2008. Slower Recovery of Lichen on Burned Caribou Winter Range in Alaska Tundra: Potential Influences of Climate Warning and Other Disturbances. Arctic, Antarctic, and Alpine Research 40: 89-95.

Johnson CJ, Boyce MS, Case RL, Cluff HD, Gau RJ, Gunn A, Mulders R. 2005. Cumulative effects of human developments on Arctic wildlife. Wildlife Monogr 160: 1-36

Johnson CJ, Boyce MS, Mulders R, Gunn A, Gau RJ, Cluff HD, Case RL. 2004. Quantifying patch distribution at multiple spatial scales: applications to wildlife-habitat models. Land Ecol 29:869-882.

Johnson CJ, Russell DE. 2014. Long-term distribution responses of a migratory caribou herd to human disturbance. Biol Conserv 177:52-63.

Johnson C. 2009. Associate Professor, University of Northern British Columbia. Prince George, BC, Canada. E-mail. June 25, 2009.

Joly K, Chapin III FS, Klein DR. 2010. Winter habitat selection by caribou in relation to lichen abundance, wildfires, grazing and landscape characteristics in northwest Alaska. Ecoscience 17:321–333.

Joly K, Chapin III FS, Klein DR. 2009. Winter habitat selection by caribou in relation to lichen abundance, wildfires, grazing and landscape characteristics in northwest Alaska. Ecoscience 17:321–333.

Joly K, Jandt RR, Klein DR. 2009. Decrease of lichens in Arctic ecosystems: the role wildfire, caribou, reindeer, competition and climate in north-western Alaska. Polar Research 28:433-442.

Joly K, Bente P, Dau J. 2007. Response of overwintering caribou to burned habitat in northwest Alaska. Arctic 60: 401-410.

Kendrick A, Lyver POB, Łutsel K'e Dene First Nation. 2005. Denesoline (Chipewyan) Knowledge of Barren-ground Caribou (*Rangifer tarandus groenlandicus*) Movements. Arctic 58:175-191.

Kerby JT, Post E. 2013. Advancing plant phenology and reduced herbivore production in a terrestrial system associated with sea ice decline. Nature Communications 4: 2514

Kershaw GP, Kershaw LJ. 1987. Successful plant colonizers on disturbances in tundra areas of Northwestern Canada. Arctic Alpine Res 19:451-460.

Knopff AA. 2011. Conserving Cougars in a Rural Landscape: Habitat Requirements and Local Tolerance in West-Central Alberta. MSc Thesis. Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada. 102 pp.

Krupa SV and Kickert RN. 1989. The Greenhouse Effect: Impacts of Ultraviolet-B (UV-B) Radiation, Carbon Dioxide ($CO_2$), and Ozone ($O_3$) on Vegetation. Environmental Pollution 61: 263-393

Lenart EA, Bowyer RT, Ver Hoef J, Ruess RW. 2002. Climate change and caribou: effects of summer weather on forage. Can J Zool 80: 664-678.

Łutsel K'e Dene Elders and Land-Users, Ellis S, Marlowe E, Catholique M, Enzoe G, Enzoe D, Desjarlais S, Basil H, Enzoe R, Isadore J, Casaway N, Enzoe T, Catholique S, Lockhart J. 2003. Ni hat'ni Watching the Land: Results and Implications of 2002-2003 Monitoring Activities in the Traditional Territory of the Łutsel K'e Denesoline. Final Report – Complete. Submitted to the WKSS, Walter and Duncan Gordon Foundation.

MacArthur RA, Johnston RH, Geist V. 1979. Factors influencing heart rate in free-ranging bighorn sheep: a physiological approach to the study of wildlife harassment. Can J Zoolog 57:2010-2021.

Mahaffey, L. and M. Miller. 1994. Chapter IV – Air Quality *in* Fire Effects Guide. National Wildfire Coordinating Group Fire Use Working Team. PMS 481. 313 pp.

Mair N. 2009. Geomatics Officer, NWT Centre for Geomatics, NWT. Personal Communication, Communicated to Geoff Mulligan of Golder Associates Ltd., Geoff_Mulligan@golder.com.

Martin J, Basille M, Van Moorter B, Kindberg J, Allainé S, Swenson JE. 2010. Coping with human disturbance: spatial and temporal tactics of the brown bear (*Ursus arctos*). Can J of Zool 88: 875-883.

Matthews S, Epp H, Smith G. 2001. Vegetation Classification for the West Kitikmeot/Slave Study Region. Final Report to West Kitikmeot/Slave Study Society. Yellowknife, NWT, Canada.

McEwan EH. 1970. Energy metabolism of barren-ground caribou. Can J Zoolog 57:201-2021.

McGarigal K, Cushman SA, Ene E. 2012. FRAGSTATS v4: Spatial Pattern Analysis Program for Categorical and Continuous Maps. Fragstats Documentation . University of Massachusetts, Amherst. Available at: http://www.umass.edu/landeco/research/fragstats/fragstats.html. Accessed: April 23, 2014.

McKeen SA, Wotawa G, Parrish DD, Holloway JS, Buhr MP, Hubler G, Fehsenfeld FC, and Meagher JF. 2002. Ozone Production From Canadian Wildfires During June and July of 1995. Journal of Geophysical Research 107: 1-25.

Messier F, Huot J, Hanaff DL, Luttich S. 1988. Demography of the George River caribou herd: Evidence of population regulation by forage exploitation and range expansion. Arctic 41:279-287.

MVRB (Mackenzie Valley Review Board). 2004. Environmental Impact Assessment Guidelines. Yellowknife, NWT, Canada.

MVRB. 2014. Revised Terms of Reference (EA1314-01) Jay Project, Dominion Diamond Ekati Corporation. July 17, 2014. Yellowknife, NWT, Canada.

Near R. 2014. Director, Winter Road Operations, Diavik Diamond Mines Inc. Yellowknife, NWT. Email to Lynnette Dagenais February 11, 2014.

Nellemann C, Cameron RD. 1998. *Cumulative Impacts of an Evolving Oil-field Complex on the Distribution of Calving Caribou*. Canadian Journal of Zoology 76:1425-1430.

Nilsson C, Svedmark M. 2002. Basic principles and ecological consequences of changing water regimes: riparian plant communities. Environmental Management: 3: 468-480.

Nishi J, Croft B, Williams J, Boulanger J, Johnson D. 2007. An estimate of breeding females in the Bathurst herd of barren-ground caribou, June 2006. Manuscript Report No. 137. Department of Environment and Natural Resources, GNWT. Yellowknife, NWT, Canada.

NSMA (North Slave Métis Alliance). 1999. Can't Live Without Work: A Companion to the Comprehensive Study Report on the Diavik Diamonds Project. . Available from http://www.ngps.nt.ca/Upload/Interveners/North%20Slave%20Metis%20Alliance/061128_NSMA_Submission_withoutwork.pdf . Accessed: July 31, 2008.

NWT Infobase. 2012. NWT Species at Risk Infobase. Available at: http://nwtspeciesatrisk.ca/tiki/tiki-index.php?page=Infobase. Accessed: November 1, 2013.

NWTMN (Northwest Territory Métis Nation). 2012. Gahcho Kué Mine Project Values, Interests, and Issues Identified at NWT Métis Nation Community TK Study Sessions. NWTMN, Fort Smith, NWT, Canada.

Ovenden L. 1986. Vegetation colonizing the bed of a recently drained thermokarst lake (Illisarvik), Northwest Territories. Can J Bot 64:2688-2692.

Parlee B, Marlow E. 1997. Traditional Knowledge on Community Health: Community-Based Monitoring. Łutselk'e Dene First Nation, Łutselk'e, NWT, Canada.

DOMINION DIAMOND

Peirce KN, Van Daele LJ. 2006. Use of a garbage dump by brown bears in Dillingham, Alaska. Ursus 17:165-177.

Polfus JL, Hebblewhite M, Heinemeyer K. 2011. Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. Biol Conserv 144:2637-2646.

Post E, Forchhammer MC. 2008. Climate change reduces reproductive success of an Arctic herbivore through trophic mismatch. Philosophical Transactions of the Royal Society B-Biological Sciences, 363:2369-2375

Post E, Klein DR. 1999. Caribou calf production and seasonal range quality during a population decline. J Wildlife Manage 63:335-345.

Reed DH, O'Grady JJ, Ballou JD, Frankham R. 2003. The frequency and severity of catastrophic die-offs in vertebrates. Animal Conservation 6:109–114.

Reimers E, Dahle B, Eftestøl S, Colman JE, Gaare E. 2007. Effects of a power line on migration and range use of wild reindeer. Biol Conserv 134: 484-494.

Reimers E, Flydal K, Stenseth R. 2000. High Voltage Power Lines and Their Effect on Reindeer: A Research Programme in Progress. Polar Res:75-82.

Reimers E. 1983. Reproduction in wild reindeer in Norway. Can J Zoolog, 61:211-217.

Rescan (Rescan Environmental Services Ltd.). 2005. Ekati Diamond Mine 2004 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2006. Ekati Diamond Mine 2005 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2007. Ekati Diamond Mine 2006 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2008. Ekati Diamond Mine 2007 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2009. Ekati Diamond Mine 2008 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2010. Ekati Diamond Mine 2009 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2011. Ekati Diamond Mine 2010 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Rescan. 2012. Ekati Diamond Mine 2011 Wildlife Effects Monitoring Program. Yellowknife, NWT, Canada.

Russell DE, Martell AM, Nixon WAC. 1993. Range Ecology of the Porcupine Caribou Herd in Canada. Rangifer Special Issue 8. 168 pp.

Russell DE. 2014. Yukon College, Whitehorse, YT. Email to James Rettie May 10, 2014.

Sadownik L, Harris H. 1995. Dene and Inuit Traditional Knowledge: A Literature Review. Canadian Circumpolar Institute, University of Alberta, Appendix 1-A2 in NWT Diamonds Project: Environmental Impact Statement Project Description, Volume I. Edmonton, AB, Canada.

SARA (*Species at Risk Act*). 2012. Public Registry: A to Z Species Index. Available at: http://www.sararegistry.gc.ca/sar/index/default_e.cfm. Accessed: November 1, 2013.

Sharma S, Couturier S, Cote SD. 2009. Impacts of climate change on the seasonal distribution of migratory caribou. Glob Change Biol 15:2549-2562.

Shaw T. n.d. Appendix B – A Case Study of Community-Based Monitoring using Traditional Ecological Knowledge in Łutselk'e, NWT. In Increasing Citizen Participation In Sustainability-Centred Environmental Assessment Follow-Up. University of Waterloo, Waterloo, ON, Canada.

Skogland T. 1984. The effects of food and maternal conditions on fetal growth and size in wild reindeer. Rangifer, 4:39-46.

Skogland T. 1990. Density dependence in a fluctuating wild reindeer herd: maternal and offspring effects. Oecologia 84:442–450.

Soulé ME, Estes JA, Berger J, Del Rio CM. 2003. Ecological effectiveness: conservation goals for interactive species. Conser Biol 17: 1238-1250.

Stankowitch T. 2008. Ungulate flight responses to human disturbances: a review and meta-analysis. Biol Conserv 141:2159-2173.

Stuart-Smith AK, Bradshaw CJA, Boutin S, Hebert DM, Rippin AB. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. J Wildlife Manage, 61:622-633.

Swift TL, Hannon SJ. 2010. Critical thresholds associated with habitat loss: a review of the concepts, evidence, and applications. Biol Rev 85: 35-53.

Tahera (Tahera Diamond Corporation). 2007. Final Report: Jericho Diamond Project 2007 Wildlife Monitoring Program Data Summary. Prepared by Golder Associates Ltd. for Tahera Diamond Corporation, Yellowknife, NWT, Canada.

TBCS (Treasury Board of Canada Secretariat). 2013. Federal Contaminated Sites Inventory. Available at: http://www.tbs-sct.gc.ca/fcsi-rscf/searchby-recherchepar-eng.aspx. Accessed: March 23, 2014.

TCWR Joint Venture (Tibbitt to Contwoyto Winter Road Joint Venture). 2000. Winter Road Regulations and Rules of the Road. Echo Bay Ltd., Edmonton, AB, Canada. BHP Billiton Ltd., Yellowknife, NWT, Canada, Diavik Diamond Mines Inc, Yellowknife, NWT, Canada. 13pp.

TCWR Joint Venture. 2013a. Facts. Available at: http://jvtcwinterroad.ca/jvwr/. Accessed: January 31, 2014.

TCWR Joint Venture. 2013b. 2013 Winter Road Updates. Available at: http://jvtcwinterroad.ca/jvwr/. Accessed: January 31, 2014.

Tews J, Ferguson MAD, Fahrig L. 2007. Modeling density dependence and climatic disturbances in caribou: a case study from the Bathurst Island complex, Canadian High Arctic. J Zool 272, 209-217

Thomas DC, Kiliaan HPL. 1998. Fire–caribou relationships: (IV) recovery of habitat after fire on winter range of the Beverly Herd. Technical Report Series 312. Canadian Wildlife Service, Prairie and Northern Region, Edmonton, AB, Canada.

Tłįchǫ Government and ENR (Department of Environment and Natural Resources). 2010. Revised Joint Proposal on Caribou Management Actions in Wek'eezihii. Submitted to Wek'eezhii Renewable Resource Board.

Toupin B, Hout J, Manseau M. 1996. Effect of insect harassment on the behaviour of the Rivière George caribou. Arctic 49: 375–382

Tyler N, Stokkan K-A, Hogg C, Nellemann C, Vistnes A-I, Jeffery G. 2014. Ultraviolet vision and avoidance of power lines in birds and mammals. Conservation Biology 3: 630-632.

Tyler NJC. 1991. Short-term behavioural responses of Svalbard reindeer *Rangifer tarandus platyrhynchos* to direct provocation by a snowmobile. Biol Conserv 56:179-194.

Tyler NJC. 2010. Climate, snow, ice, crashes, and declines in populations of reindeer and caribou (Rangifer tarandus L.). Ecological Monographs 80: 197 – 219

Underhill JE, Angold P. 2000. Effects of roads on wildlife in an intensively modified landscape. Environ Rev 8: 21–39.

USDA (United States Department of Agriculture). 2009. MODIS Active Fire Detections for CONUS (2009) Through 12/31/2009 2300 MST.

Vistnes I, Nellemann C, Jordhøy P, Strand O. 2001. Wild reindeer: impacts of progressive infrastructure development on distribution and range use. Polar Biology 24: 531-537.

Vistnes I, Nellemann C. 2001. Avoidance of cabins, roads, and power lines by reindeer during calving. J Wildl Manage 65: 915–925.

Vistnes I, Nellemann C. 2008. The matter of spatial and temporal scales: a review of reindeer and caribou response to human activity. Polar Biology 31:399-407.

Vistnes II, Nellemann C, Jordhøy P, Støen, O-G. 2008. Summer distribution of wild reindeer in relation to human activity and insect stress. Polar Biology 31:1307-1317.

Vors LS, Boyce MS. 2009. Global declines of caribou and reindeer. Glob Change Biol. doi: 10.1111/j.1365-2486.2009.01974.x

Walther GR, Post E, Convey P, Menzel A, Parmesan C, Beebee TJC, Fromentin JM, Hoegh-Guldberg O, Bairlein F. 2002. Ecological responses to recent climate change. Nature 416: 389-395.

Weaver JL, Paquet PC, Ruggiero LF. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. Conserv Biol 10:964-976.

Wein RW. 1976. Frequency and Characteristics of Arctic Tundra Fires. Arctic 29: 213-222.

Weladji RB, Holand O, Almoy A. 2003. Use of climatic data to assess the effect of insect harassment on the autumn weight of reindeer (*Rangifer tarandus*) calves. J Zoolog 260:79-85.

Weladji RD, Holand O. 2003. Global climate change and reindeer: effects of winter weather on the autumn weight and growth of calves. Oecologia 136: 317-323.

Weledeh Yellowknives Dene. 1997. Weledeh Yellowknives Dene: A Traditional Knowledge Study of Ek'ati. Yellowknives Dene First Nation Council, Dettah, NWT, Canada.

White RG, Daniel CJ, Russell DE. 2013. CARMA's integrative modeling: historical background of modeling caribou and reindeer biology relevant to development of an energy/protein model. Rangifer Special Issue 21: 153-160.

Witter RA, Johnson CJ, Croft B, Gunn A, Gillingham MB. 2012. Behavioural trade-offs in response to external stimuli: time allocation of an Arctic ungulate during varying intensities of harassment by parasitic flies. J Anim Ecol 81:284-295.

WKSS (West Kitikmeot Slave Study Society). 2001a. West Kitikmeot Slave Study Final Report. 105 pp. Yellowknife. NWT, Canada.

WKSS. 2001b. Caribou Migration and the State of Their Habitat. Final Report. Submitted by Dogrib Treaty 11 Council. 120 pp.

Wulder M. 2002. Mapping the land cover of the forested area of Canada with Landsat data. Proceedings of the 2002 International Geoscience and Remote Sensing Symposium, June 24-28, Toronto, Canada. 4pp. Available online: http://cfs.nrcan.gc.ca/files/498. Accessed 25 September 2009.

Zalatan R, Gunn A, Henry GHR. 2006. Long-Term Abundance Patterns of Barren-Ground Caribou Using Trampling Scars on Roots of *Picea mariana* in the Northwest Territories, Canada. Arct Antarct Alp Res, 38: 624-630.

## 12.9 Glossary

| Term | Definition |
|---|---|
| Abundance | The number of individuals in a given area or sample. |
| Acid Rock Drainage | Acidic pH rock drainage due to the oxidation of sulphide minerals that includes natural acidic drainage from rock not related to mining activity; an acidic pH is defined as a value less than 6.0. |
| Acidification | The decrease of acid neutralizing capacity in water, or base saturation in soil, caused by natural or anthropogenic processes. Acidification is exhibited as the lowering of pH. |
| All-season road | A road that is motorable all year by the prevailing means of rural transport. |
| Annual home range | The area traversed by animals in its normal activities of food gathering, mating and caring for young. Occasional sallies outside the area, perhaps exploratory in natures, should not be considered part of the home range. An alternative, statistical explanation is the smallest sub-region, which that accounts for a specified proportion of its total utilization over the course of the year. |
| Annuals Plants | Plants with a life cycle that lasts only one year. They grow from seed, bloom, produce seeds, and die in one growing season. They then need to be replanted each spring. Most annuals bloom for a long time. |
| Anthropogenic | Human-related, often referring to an activity, development or disturbance on the landscape. |
| Application Case | The Environmental Assessment (EA) case that includes the Project and existing and approved developments or activities. |
| Assessment Endpoints | Qualitative expressions used to assess the significance of effects on valued components and represent the key properties of valued components that should be protected for future human generations (i.e., incorporate sustainability). |
| Babiche | A type of cord or lacing made from rawhide. |
| Barren Kimberlite | Kimberlite that does not contain diamonds. |
| Barrenland | The area of the Northwest Territories east of the Mackenzie River valley and north and east of the tree line characterized by a low rolling tundra landscape, continuous permafrost, and low densities of human settlement. |
| Base Case | The assessment case that includes existing environmental conditions as well as existing and approved projects or activities, before the construction of the Project in question, acts as reference against which data from construction and operational phases of development will be compared. |
| Baseline | Background or reference; conditions before Project development. |
| Baseline Study Area | The area where direct effects and small-scale indirect effects from the Project are expected to occur. |
| Biomass | The weight of living matter in a given area or sample. |
| Bog | A peatland with weakly to moderately decomposed sphagnum and forest peat material formed in oligotrophic environments. The bog surface is acidic and low in nutrients due to the slightly raised peat surfaces disassociating it from underlying and surrounding mineral rich soil waters. |
| Boreal Forest | The forested area within the boreal zone of Canada. |
| Broadleaf tree | Deciduous tree species such as aspen or paper birch. |
| Bryoid | Bryophytes (mosses, liverworts and hornworts) and lichens on the soil surface. |
| Bryophytes | Non-vascular plants from the phylum Bryophyta (a division of the plant kingdom). Species within this phylum include mosses, liverworts and hornworts. |
| Caribou Energetics Model | Modelling approach used to estimate birth rates associated with a number of land-use scenarios across a continuum from no active mines to several times the current area of active mines. |
| Carnivore | An animal that preys on other animals; especially any mammal of the Order Carnivora including wolves, bears, and wolverine. |
| Carrying Capacity | The maximum population of a given organism that a particular environment or habitat can sustain; implies continuing yield without environmental damage. |
| Catchment Area | An area of land where water from precipitation drains into a body of water. |

| Term | Definition |
| --- | --- |
| Claim Block | Publicly owned land that has been leased from the government of the Northwest Territories. |
| Coefficients | A multiplicative factor of a quantitative term |
| Confidence Interval | A range of values so defined that there is a specified probability that the value of a parameter lies within it. |
| Coniferous | A tree that bears cones. Evergreens compose the majority of this type of tree. They are called evergreens because they do not shed their leaves all at once in the fall. |
| Cumulative Effects | The combined effects of past, present and reasonably foreseeable activities, over time, on people and the environment. |
| Deflection Paths | A change in movement path direction as the result of a barrier to usual progress. |
| Developer’s Assessment Report (DAR) | A report of environmental impact assessment prepared by a developer and submitted for environmental impact review in advance of construction of a proposed development. |
| Dewatering | Removal of water from a natural waterbody by pumping or draining. |
| Dike | A man-made barrier for the purpose of containing water. |
| Disturbance Coefficient | The effectiveness of the habitat within the disturbance zone of influence in fulfilling the requirements of a species. |
| Drawdown | A lowering of the water level in a reservoir or other body of water. |
| Ecological Landscape Classification (ELC) | A cartographical delineation of distinct ecological areas, identified by their geology, topography, soils, vegetation, climate conditions, living species, water resources, as well as anthropic factors. |
| Ecoregion | Relatively homogeneous subdivisions of an ecozone, which are characterized by distinctive climatic zones or regional landforms. |
| Ecosystem | Ecological system consisting of all the organisms in an area and the physical environment with which they interact. |
| Effects Study Area | The spatial extent over which effects are studied. |
| Emissions | The act of releasing or discharging air contaminants into the ambient air from any source. Release of substances to atmosphere (can be fugitive emission, stack emission, diesel exhaust, mechanical ground disturbance). |
| Endogenous reserves | Energy reserves stored within the body, generally as lipids (fat) or protein (muscle). |
| Energetics Model | Refers to a model of factors affecting metabolic rate and energy consumption of a given animal. |
| Energy Balance | The net difference between energy production and expenditure |
| Erosion | (i) The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. (ii) Detachment and movement of soil or rock by water, wind, ice, or gravity. |
| Esker | Linear structures of loose sand and gravel, formed by glacial rivers. They Eskers provide critical habitat for carnivores and ungulates in the Arctic. |
| Extirpation | The condition of a species (or other taxon) in which the species ceases to exist in the chosen geographic area of study, though it still exists elsewhere. Local extinctions are contrasted with global extinctions. |
| Fauna | The animals of a particular region, habitat, or geological period. |
| Fecundity | A measure of reproductive potential. It is the number of female offspring produced by each female in a population. It is calculated as the proportion of females conceiving, multiplied by the number and sex ratio of the offspring produced. |
| Feeding intensity | Ratio of time eating to total time eating and searching. |
| Fen | A fen is a peat-covered or peat-filled wetland with a high water table, which is not hydrologically isolated and receives water from streams and/or groundwater. |
| Fly Rock | Material that is projected outside the declared danger zone by a quarry blast. Fly rock may be caused by poor blast design or unexpected zones of weakness in the rock. |
| Footprint | The proposed development area that directly affects the soil and vegetation components of the landscape. |
| Fugitive dust | Particulate matter suspended in the air by wind action and human activities. |

| Term | Definition |
|---|---|
| Genus | A low-level taxonomic rank used in the classification of living and fossil organisms. |
| Geochemistry | The chemistry of the composition and alterations of solid matter such as sediments or soil. |
| Geographic Information System | Computer system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data. |
| Glaciofluvial deposits | Glaciofluvial deposits were left behind by rivers that helped drain melting glaciers. |
| Global Positioning System | A space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more Global Positioning System satellites. |
| Groundwater | That part of the subsurface water that occurs beneath the water table, in soils and geologic formations that are fully saturated. |
| Grubbing | Removal and disposal of stumps and roots. |
| Guy wires | Wires or cables that are used to keep something upright. |
| Habitat | The physical space within which an organism lives, and the abiotic and biotic entities (e.g., resources) it uses and selects in that space. |
| Habitat Fragmentation | A process by which habitats are increasingly subdivided into smaller units, resulting in their increased restriction as well as an overall loss of habitat area and biodiversity. |
| Headwater | A tributary stream of a river close to or forming part of its source. |
| Heath tundra | A closed mat plant community that grows on moderate to well drained soils, covering most of the upland areas. Plants generally belong to the heath family, the Ericaceae. The vegetation layer forms a mat of low shrubs dominated by dwarf birch and Labrador tea. |
| Herbs | A vascular plant (forb or graminoid) without a woody stem. |
| Home Range | The area traversed by an animal during its activities during a specific period of time. |
| Hydrology | Science that deals with the waters above the land surfaces of the Earth, their occurrence, circulation and distribution, both in time and space, their biological, chemical and physical properties, their reaction with their environment, including their relation to living beings. |
| Inuksuk | Although several forms exist, those identified in this study are stacked stone features ranging from columns of flat rock or boulders to anthropomorphic figures of more recent construction. Inuksuit (plural) have been interpreted as guides or markers strategically placed on terrain to mark trails, good hunting and fishing locations, and spiritual places, or to help herd caribou during migrations. |
| Kernel density | A non-parametric way to estimate the probability density function of a random variable. Kernel density estimation is a fundamental data smoothing problem where inferences about the population are made, based on a finite data sample. |
| Key Line of Inquiry | Areas of the greatest concern that require the most attention during the environmental impact review and the most rigorous analysis and detail in the DAR. Their purpose is to ensure a comprehensive analysis of the issues that resulted in significant public concern about the proposed development. |
| Kimberlite | Igneous rocks that originate deep in the Earth's mantle and intrude the Earth's crust. These rocks typically form narrow pipe-like deposits that sometimes contain diamonds. |
| Kimberlite Pipe | Vertical structures on which kimberlites occur in the Earth's crust. |
| Landscape | Mosaic of patches that differ in ecologically important properties. |
| Landfarm | A bioremediation treatment process that is performed in the upper soil zone or in biotreatment cells. Contaminated soils, sediments, or sludges are incorporated into the soil surface and periodically turned over (tilled) to aerate the mixture. |
| Laydown Areas | An area that has been cleared for the temporary storage of equipment and supplies. Laydown areas are usually covered with rock and/or gravel to ensure accessibility and safe maneuverability for transport and off-loading of vehicles. |
| Lichen veneer | A continuous mat of lichen that appears as a "veneer". These sites are windswept and dry, allowing very little other plant growth. Lichen veneer consists mainly of Iceland moss, several other species of Cetraria, green and black hair lichens, grey mealy lichen, worm lichens and other species. |

| Term | Definition |
|---|---|
| Lichens | A simple slow-growing plant that typically forms a low crust-like, leaf-like, or branching growth on rocks, walls, and trees. |
| Littoral | Of, relating to, or situated on the shore of the sea or a lake. |
| Long Lake Containment Facility | A facility to receive and store fine processed kimberlite and waste water |
| Mackenzie Valley Review Board | An organization that conducts environmental impact assessments in the Mackenzie Valley that protect the environment, including the social, economic and cultural well-being of its residents. |
| Mean | Average value. The mean is found by adding up all the values and then dividing the sum by the number of values. |
| Mesic | A moderate soil moisture regime value whereby water is removed somewhat slowly in relation to supply; neither wet nor dry. Available soil water reflects climatic inputs. |
| Metabolic rates | Rate of energy expenditure by humans and other animals. |
| Metal Leaching | Removal of metals by dissolution, desorption, or other chemical reaction from a solid matrix by passing liquids through the material. |
| Metasediment Rock | Sedimentary rocks that have been modified by metamorphic processes. |
| Minewater | Subterranean or surface water that enters mining excavations and undergoes physicochemical changes during mining operations. |
| Mitigation | The elimination, reduction or control of the adverse environmental effects of a project, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation, or any other means. |
| Mixedwood | A terrestrial forest type that is an assemblage of both deciduous and coniferous tree species. |
| Nutrients | Environmental substances (elements or compounds) such as nitrogen or phosphorus, which are necessary for the growth and development of plants and animals. |
| Nutrient cycling | The movement and exchange of organic and inorganic matter back into the production of living matter. |
| Open-Water Season | Summer season when lakes, rivers and streams are free of ice (generally June or July to October). |
| Ore | The naturally occurring material from which a mineral or minerals of economic value can be extracted. |
| Organic matter | Plant and animal materials that are in various stages of decomposition. |
| Oxides of Nitrogen (NOx) | Consist of nitric oxide (NO) and nitrogen dioxide ($NO_2$) and are reported as equivalent $NO_2$. |
| Ozone | An inorganic molecule with the chemical formula $O_2$. |
| Particulate Matter | Any aerosol that is released to the atmosphere in either solid or liquid form. |
| Parturition | Giving birth to young. |
| Patch | A particular unit of habitat with identifiable boundaries that differs from its surroundings in one or more ways. Habitat boundaries can be a function of vegetative composition, structure, or age, or a combination of the three. |
| Peat bog | Sphagnum or forest peat materials formed in an ombrotrophic environment due to the slightly elevated nature of the bog, which tends to disassociate it from the nutrient-rich groundwater or surrounding mineral soils. Characterized by a level, raised or sloping peat surface with hollows and hummocks. |
| Permafrost | Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years. Permafrost is defined on the basis of temperature. It is not necessarily frozen, because the freezing point of the included water may be depressed several degrees below 0°C; moisture in the form of water or ice may or may not be present. |
| pH | The negative log of the concentration of the hydronium ion. The pH is a measure of the acidity or alkalinity of all materials dissolved in water, expressed on a scale from 0 to 14, where 7 is neutral, values below 7 are acidic, and values over 7 are alkaline. |
| Photosynthesis | A chemical reaction that occurs in the chloroplasts of algae and plants and involves the conversion of water and carbon dioxide into organic carbon. |
| Physiology | The scientific study of function in living systems |

| Term | Definition |
|---|---|
| Polygon | The spatial area delineated on a map to define one feature unit (e.g., one type of ecosite phase). |
| Processed Kimberlite | The residual material left behind when the processing of kimberlite has been completed to extract the diamonds. |
| Reasonably Foreseeable Development Case | The assessment case including existing and approved developments, the Project, and reasonably foreseeable developments that were known as of six months prior to the Environmental Assessment Certificate Application submission date. |
| Reclamation | The process of reconverting disturbed land to its former or other productive uses. |
| Reconnaissance Survey | A preliminary survey. |
| Regional Study Area | Represents the area of study for the assessment of cumulative (combined) effects of the Project and other past, existing or planned developments. |
| Residual Effects | Effects that remain after mitigation has been applied. |
| Resource Selection Function | A model of how animals select resources. These estimate the relative probability that a resource will be selected. |
| Riparian | Terrain, vegetation or a position next to or associated with a stream, floodplain or standing waterbody. |
| Runoff | The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate. |
| Seasonal range | The area traversed by animals in its normal activities of food gathering, mating and caring for young during different seasons. Occasional sallies outside the area, perhaps exploratory in natures, should not be considered part of the home range. An alternative, statistical explanation is the smallest sub-region, which accounts for a specified proportion of its total utilization over the course of a season. |
| Sedge | A grass-like plant with a triangular stem often growing in wet areas. Sedge wetland habitats are typically wet sedge meadows and other sedge associations of non-tussock plant species. Sedge species such as *Carex aquatilis* and *C. bigelowii*, and cotton grass (*Eriophorum angustifolium*) are the dominant vegetation types. Plant species occupy wet, low-lying sites where standing water is present throughout much of the growing season. |
| Seepage | Slow water movement in subsurface. Flow of water from man-made retaining structures. A spot or zone, where water exits the ground, often forming the source of a small spring. |
| Sensory Disturbance | Visual, auditory, or olfactory stimulus that creates a negative response in wildlife species. |
| Silt | As a particle size term: a size fraction between 0.002 and 0.05 mm equivalent diameter, or some other limit (geology or engineering). |
| Silt Curtain | A semi-permeable fabric designed to prevent silt from entering a water body. |
| Species | A group of organisms that actually or potentially interbreed and are reproductively isolated from all other such groups; a taxonomic grouping of genetically and morphologically similar individuals; the category below genus. |
| Species richness | The number of different species occupying a given area. |
| Staging Area | Area located next to a highway that allows marshalling of oversized loads. |
| Successional Stage | The observed process of change in the species structure of an ecological community over time. |
| Taiga | A biome characterized by coniferous forests consisting mostly of pines, spruces and larches. |
| Terms of Reference | The Terms of Reference identify the information required by government agencies for an Environmental Impact Assessment. |
| Thermistor | A device whose electrical resistance, or ability to conduct electricity, is controlled by temperature. |
| Total suspended particulates | A term used to collectively describe tiny airborne particles or aerosols that are less than 100 micrometres in size. |
| Traditional Knowledge | The knowledge, innovations, and practices of indigenous people; refers to the matured long-standing traditions and practices of certain regional, indigenous, or local communities. |

| Term | Definition |
|---|---|
| Traditional Land Use | Use of the land by Aboriginal groups for harvesting traditional resources such as wildlife, fish or plants, or for cultural purposes such as ceremonies or camping. |
| Transect | A method of sampling snow along a path or fixed line. |
| Tundra | A type of ecosystem dominated by lichens, mosses, grasses, and woody plants; a treeless plain characteristic of the Arctic and sub-Arctic regions. |
| Valued Components | Represents physical, biological, cultural, and economic properties of the social-ecological system that is considered to be important by society. |
| Vascular Plant | Plants possessing conductive tissues (e.g., veins) for the transport of water and food. |
| Veneer | Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer ranges from 10 cm to 1 m in thickness and possesses no form typical of the materials' genesis. |
| Waste Rock | Rock moved and discarded in order to access resources. |
| Waste Rock Storage Areas | Engineered landforms in which waste rock from mining activities is stored. |
| Waterbody | An area of water such as a river, stream, lake or sea. |
| Watershed | The upstream land area drained by a river network. |
| Wetland | Wetlands are land where the water table is at, near, or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or "peatlands," and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat. |
| Wildlife | Under the Species at Risk Act, wildlife is defined as a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus that is wild by nature and is native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years. |
| Zone of Influence | The area surrounding a development site in which animal occurrence is reduced, possibly due to avoidance of sensory disturbances or low-quality habitat. Could also be an area of attraction. |