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8.0 KEY LINE OF INQUIRY: CARIBOU AND CARIBOU HABITAT

8.1 Introduction

8.1.1 Context

This section of the Developer's Assessment Report (DAR) for the NICO Cobalt-Gold-Copper-Bismuth Project (NICO Project) consists solely of the Key Line of Inquiry (KLOI) for Caribou and Caribou Habitat. In the Terms of Reference (TOR) for the NICO Project's DAR issued on 30 November 2009, the Mackenzie Valley Review Board (MVRB) identified caribou as 1 of 3 top priority valued components requiring a high level of consideration by the developer (MVRB 2009).

The KLOI: Caribou and Caribou Habitat includes a detailed and comprehensive assessment of all potential impacts from the NICO Project on barren-ground and woodland caribou, including traditional and non-traditional uses of caribou. It also includes the specific effects that changes in the caribou abundance and distribution would have on the social, cultural, and economic well-being of residents of the region.

All impacts on caribou are assessed in detail in the KLOI: Caribou and Caribou Habitat; however, the following subjects of note address issues that may overlap slightly with this KLOI:

- Traditional Knowledge (Section 5);
- Air Quality (Section 10);
- Vegetation (Section 14);
- Human Environment (Section 16); and
- Biophysical Environment Monitoring and Management Plans (Section 18).

8.1.2 Purpose and Scope

The purpose of the KLOI: Caribou and Caribou Habitat is to assess the effects of the NICO Project on caribou and to meet the TOR issued by the MVRB. The terms for the KLOI: Caribou and Caribou Habitat are shown in Table 8.1-1. The entire TOR document is included in Appendix 1.I and the complete table of concordance for the DAR is in Appendix 1.II of Section 1.

The KLOI: Caribou and Caribou Habitat includes an assessment of direct and indirect effects from the NICO Project on all life stages of caribou herds within the study area. Caribou populations that may interact with the NICO Project (based on potential overlap with seasonal ranges) include the Bathurst, Bluenose East, and Ahiak barren-ground herds, and the woodland (or boreal) ecotype. This assessment includes potential behavioural changes resulting from NICO Project-related components and associated activities, including sensory disturbance, and effects on foraging, resting, and caribou movements within the study area.

The effects assessment will evaluate all NICO Project phases, including construction, operation, and closure and reclamation. NICO Project-specific (incremental) and cumulative effects have been incorporated throughout this section. Given the size of the seasonal ranges of caribou, the effects from the NICO Project must be considered in combination with other developments, activities, and natural factors that influence caribou within their seasonal ranges.

Information from other components of the DAR, including air quality, water quality, vegetation, and other wildlife, as well as information from existing developments, is incorporated in the effects assessment for caribou. In addition, the potential effects to traditional and non-traditional use of caribou from changes to the populations are summarized. More detailed information on the requirements of the DAR TOR for this KLOI can be found in Table 8.1-1.

Table 8.1-1: Key Line of Inquiry: Caribou and Caribou Habitat Concordance with the Terms of Reference

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
3.1.1	**Issues Prioritization** Fortune is required to give special consideration to the following key lines of inquiry in the Developer's Assessment Report	8.0
	• **Caribou and caribou habitat**, including effects from the NICO mine site and NICO access road on habitat, disturbance and displacement effects and direct mortality.	
3.2.3	**Developer's assessment boundaries** The developer will describe and provide rationales for:	
	1) An overall environmental assessment study area and the rationale for its boundaries;	8.1.3.2, 8.1.3.3, 8.1.3.4
	2) Fortune's chosen spatial boundaries for the assessment of potential impacts for each of the valued components considered; and	8.1.3.2, 8.1.3.3, 8.1.3.4
	3) The temporal boundaries chosen for the assessment of impacts on each valued component.	8.1.3
3.2.4	**Description of the Existing Environment**	
	The developer is encouraged to provide a description of the methods used to acquire the information used to describe baseline conditions.	8.3.1
3.3.1	**Impact Assessment Steps and Significance Determination Factors** In assessing impacts on the biophysical environment, the *Developer's Assessment Report* will for each subsection:	
	• Identify any valued components used and how they were determined;	8.1.2
	• For each valued component, identify and provide a rationale for the criteria and indicators used;	8.1.2
	• Identify the sources, timelines and methods used for data collection;	8.3.1
	• Identify natural range of background conditions (where historic data are available), and current baseline conditions, and analyze for discernible trends over time in each valued component, where appropriate, in light of the natural variability for each;	8.3.2
	• Identify any potential direct and indirect impacts on the valued components that may occur as a result of the proposed development, identifying all analytical assumptions;	8.4
	o Predict the likelihood of each impact occurring prior to mitigation measures being implemented, providing a rationale for the confidence held in the prediction;	8.4

Table 8.1-1: Key Line of Inquiry: Caribou and Caribou Habitat Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
	o Describe any plans, strategies or commitments to avoid, reduce or otherwise manage the identified potential adverse impacts, with consideration of best management practices in relation to the valued component or development component in question;	8.4
	o Describe techniques, such as models utilized in impact prediction including techniques used where any uncertainty in impact prediction was identified;	8.5
	• Assess and provide an opinion on the significance of any residual adverse impacts predicted to remain after mitigation measures; and	8.7.2, 8.8.2
	• Identify any monitoring, evaluation and adaptive management plans required to ensure that predictions are accurate and if not, to proactively manage against adverse impacts when they are encountered.	8.10, 18.0, Appendix 18.II
	The developer will characterize each predicted impact. These criteria will be used by the developer as a basis for its opinions on the significance of impacts on the biophysical environment. The Review Board will make ultimate determinations of significance after considering all the evidence on the public record later in the environmental assessment	8.7.2
3.3.4	**Key Line of Inquiry: Caribou and Caribou Habitat** The developer will:	
	• Describe impacts to caribou habitat, including degradation and fragmentation, with a focus on important wildlife habitat.	8.5.2, 8.5.3
	• Describe potential for increased mortality from all sources including vehicle collisions and changes to hunting access.	8.4.2.1, 8.4.2.2, 8.5.4, 8.5.5
	• Describe effects of increased sensory disturbance from all sources (e.g. noise, odours, activity, vibrations, overflights and dust) and effective habitat loss resulting from changed behavior.	8.5.4
	• Describe any disruption of movement and migration patterns.	8.5.3, 8.6.2
	• Describe potential for increased contamination of food and water, including bio-accumulation from all sources.	8.4.2.1
	• Discuss energetic costs to caribou from disturbance and displacement effects.	8.5.4, 8.6.3
	• Describe mitigation measures used to mitigate impacts on caribou and caribou habitat.	8.4.2, 8.10
3.6	**Cumulative Effects** Pursuant to paragraph 117(2)(a) of the *Mackenzie Valley Resource Management Act*, the Review Board considers cumulative effects in its determinations. Cumulative effects are the combined effects of the development in combination with other past, present or reasonably foreseeable future developments and human activities. In addressing cumulative effects, the developer is encouraged to refer to Appendix H of the Review Board's Environmental Impact Assessment Guidelines. The developer will:	

Table 8.1-1: Key Line of Inquiry: Caribou and Caribou Habitat Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
3.6 (continued)	• Describe and provide rationale for which past, present or reasonably foreseeable future developments and human activities are being considered in the cumulative effects assessment.	8.5.1
	• Identify which of the valued components may be affected by other past, present or reasonably foreseeable future developments and human activities.	8.5, 8.9.1
	• Assess the likelihood, duration and magnitude of the combined effect of these human activities on the identified valued components.	8.7.1, 8.7.2
	• Describe any mitigation measures proposed to reduce or avoid the predicted effects, specifying if and how adaptive management will be used, and provide an assessment of any residual cumulative impacts.	8.7.2
Appendix A	**Existing Environment**	
	Biophysical environment Describe the biophysical environment within the relevant environmental assessment study areas. The following description should be at a level of detail sufficient to allow for a thorough assessment of NICO Project effects. Describe the following:	
	8) Wildlife (including resident and migratory bird species), wildlife habitat and migration corridors. Special emphasis will be placed on key harvested species including moose, caribou and furbearers. Where available, the following information is required for each species:	
	a. population trends, including abundance, distribution and demographic structures;	8.3.2.1, 8.3.2.2
	b. habitat requirements, including identification of local areas of important habitat, attributes of the seasonal habitats that relate to how the species use them (e.g. travel routes, forage) and sensitive time periods;	8.3.2.1, 8.3.2.2
	c. migration routes, patterns and timings including typical patterns and the range of known variation;	8.3.2.1, 8.3.2.2
	d. factors known or suspected to be currently affecting the species in the environmental assessment study area (e.g. harvesting, disease);	8.3.2.1, 8.3.2.2
	e. known or suspected sensitivities to human activities; and	8.3.2.1, 8.3.2.2
	f. gaps in current knowledge of the species such as the impacts of disturbance on behaviour or abundance.	8.3.2.1, 8.3.2.2
Appendix L	**Cumulative Effects**	
	The following items are required for consideration of cumulative effects:	
	1) In terms of cumulative effects, predict:	
	a. potential impacts of the NICO Project on the Bathurst caribou herd in combination with impacts of other developments in the range of the Bathurst caribou herd;	8.5, 8.7, 8,8

Table 8.1-1: Key Line of Inquiry: Caribou and Caribou Habitat Concordance with the Terms of Reference (continued)

Section in Terms of Reference	Requirement	Section in Developer's Assessment Report
	e. potential impacts of the NICO Project on fish and wildlife in combination with impacts from past or present pollution from contaminated sites in the area, including Rayrock and Colomac	12.0, 8.5, 8.7, 8.8, 8.9

Valued components (VCs) represent physical, biological, cultural, social, and economic properties of the environment that are considered to be important by society. The inter-relationships between components of the biophysical and socio-economic (human) environments provide the structure of a social-ecological system (Walker et al. 2004; Folke 2006). The TOR identified caribou as a primary VC for the DAR (MVRB 2009). Caribou are an important cultural and economic resource for the people in the Northwest Territories (NWT). Disturbance and contamination of caribou habitat have the potential to adversely affect caribou health and populations, while contaminants in the caribou meat and changes to the population can have the potential to adversely affect human health and the continued use of caribou by people.

Assessment endpoints represent the key properties of the VC that should be protected for their use by future human generations, while measurement endpoints are quantifiable (i.e., measurable) expressions of changes to assessment endpoints (Section 6.2). Assessment and measurement endpoints for caribou are presented in Table 8.1-2.

Table 8.1-2: Summary of the Assessment and Measurement Endpoints for Key Line of Inquiry Caribou and Caribou Habitat

Valued Component	Assessment Endpoints	Measurement Endpoints
Caribou	• Persistence of caribou populations • Continued opportunity for traditional and non-traditional use of caribou	• Habitat quantity and fragmentation • Habitat quality • Relative abundance and distribution of caribou • Survival and reproduction
People		• Access to caribou • Availability of caribou

8.1.3 Study Areas

8.1.3.1 General Setting

The NICO Project is approximately 160 kilometres (km) northwest of Yellowknife in the NWT (Figure 8.1-1). The NICO Project is located within the Marian River drainage basin, approximately 10 km east of Hislop Lake at a latitude of 63^{o}33' North and a longitude of 116^{o}45' West, and within the Taiga Shield and Taiga Plains Ecoregions (Ecosystem Classification Working Group 2007, 2008). The Project spans 2 Level II Ecoregions: Taiga Shield and Taiga Plains.

The Taiga Shield High Boreal Level III Ecoregion is bedrock-dominated with jack pine (*Pinus banksiana*) and mixed spruce forests on rock outcrops. White spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) stands are found in low-elevation areas with adequate nutrient and water supplies. Peat plateaus and shore and floating fens are scattered throughout the Ecoregion (Ecosystem Classification Working Group 2008).

The Taiga Plains Ecoregion is comprised of the Great Slave Uplands High Boreal and Central Great Bear Plains Low Subarctic Level III Ecoregions. The Great Slave Uplands region is dominated by low-growing open black spruce (*Picea mariana*) forests, treed bogs, horizontal fens, and peat plateaus are dominant. Upland deciduous, mixedwood, and coniferous stands are found in elevated areas with better drainage (Ecosystem Classification Working Group 2007). The Central Great Bear Plains Ecoregion is dominated by closed to open mixed spruce forest with shrub, moss, and lichen understories or regenerating dwarf birch. Pond and fen complexes are scattered throughout, while closed mixedwood, white spruce, and jack pine stands occupy rolling to ridged glacial flutings (Ecosystem Classification Working Group 2007).

100 0 100

SCALE 1:3,000,000 KILOMETRES

LEGEND

- NICO PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- RAILROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

LOCATION OF THE NICO PROJECT

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-054-GIS				
PROJECT No. 09-1373-1004		SCALE AS SHOWN		REV. 0
DESIGN	JG	17 Jan. 2011	FIGURE: 8.1-1	
GIS	ANK	25 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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The NICO Project is located approximately 50 km northeast of Whatì and 70 km south of Gamètì, the nearest communities. Other communities include Behchokǫ̀, approximately 85 km southeast of the NICO Project, and Wekweètì, located approximately 140 km northeast of the NICO Project. All of these communities are within Tłįchǫ Lands. The NICO Project is surrounded by Tłįchǫ Lands. The mean annual temperature for this region is -4.6 degrees Celcius (°C) (Environment Canada; Yellowknife A Weather Station 2010, internet site). July is the warmest month with a mean temperature of 16.8 °C, whereas January is typically the coldest month with a mean temperature of -26.8 °C. The mean annual precipitation is approximately 280.7 millimetres (mm), with 164.5 mm falling as rain and the remainder as snow.

To facilitate the assessment and interpretation of potential effects associated with the NICO Project, it is necessary to define appropriate spatial boundaries. Study area boundaries were delineated based on the predicted spatial extent of the NICO Project-related effects and the life history attributes of caribou potentially influenced by the NICO Project. The following 3 spatial boundaries were used to assess effects on caribou and caribou habitat:

- caribou study area was used to assess the incremental and cumulative effects from the NICO Project and other developments (e.g., Proposed Tłįchǫ Road Route) on caribou;
- regional study area (RSA) was used to assess the combined direct and indirect effects from the NICO Project on caribou; and
- local study area (LSA) for small-scale direct and indirect effects from the NICO Project, which consists of the NICO mine site and 27 km Proposed NICO Project Access Road (NPAR).

8.1.3.2 Caribou Study Area

Barren-ground and woodland caribou ecotypes have the potential to interact with the NICO Project. Based on annual and seasonal range estimates, the winter ranges of the Bathurst, Bluenose East, and Ahiak barren-ground herds have the potential to overlap with the NICO Project (Section 8.3.2.2.1). Annual and seasonal ranges for each caribou herd were calculated using satellite and global positioning system collar data (courtesy of Government of Northwest Territories (GNWT) Department of the Environment and Natural Resources [ENR],) and a 95 percent (%) kernel density (i.e., probability density) estimate. Further analysis of collar data showed that the Bathurst caribou herd has the greatest probability of being affected by the NICO Project, as collared individuals have been recorded in the RSA during several years (Section 8.3.2.2.1). Bluenose East caribou are not likely to be influenced by the NICO Project in most years, as only 1 collared individual has been recorded within 50 km of the NICO Project from 1996 through 2010. Individuals from the Ahiak caribou herd have the lowest likelihood of being influenced by the NICO Project, as collared individuals from this herd have not been recorded within 50 km of the NICO Project.

For woodland caribou, the RSA is within the range identified for the NWT North Slave woodland caribou population (ENR 2009a). However, John Mantla (Behchokǫ̀, 2003, pers comm.) indicated that he knew of no traditional hunting of woodland caribou in the area, and believed that they were not commonly present in the study area. Traditional knowledge indicates that woodland caribou tend to be more common to the west of the RSA, beyond the community of Whatì (Dogrib Treaty 11 Council 2001).

Therefore, the assessment of the effects from the NICO Project and other developments is completed on the Bathurst caribou herd, which has the greatest likelihood to be influenced by the NICO Project. In addition, much of the current information on habitat selection, effects from arctic mining activities, and demography (reproduction and survival rates) for caribou is for the Bathurst herd. Potential effects predicted for the Bathurst herd are anticipated to be representative and provide conservative estimates of effects for other caribou populations (i.e., predicted effects from the NICO Project on the Bathurst herd would overestimate effects on other caribou herds).

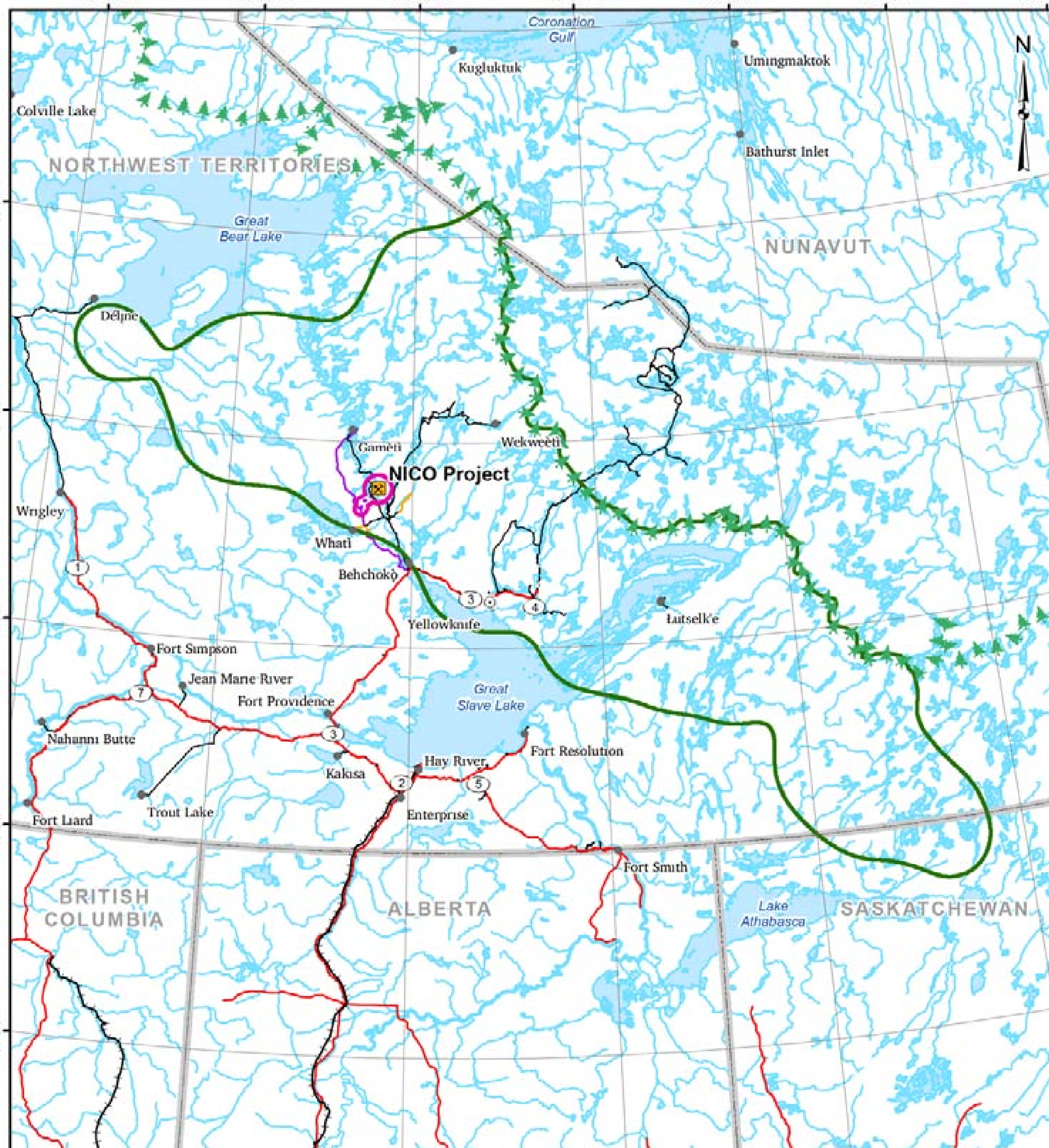
For Bathurst caribou, individuals in the population are predicted to experience the effects from the NICO Project and other developments while moving around their winter range. Examination of the collar data indicate that 89% of caribou locations were below the treeline during the winter period (Appendix 8.II). In addition, the influence of human disturbance on caribou distribution suggests that the response of individuals to development is likely different in the forest than on the tundra, which may be related to the function and structure of available habitat types (Section 8.1.3.3). Therefore, the caribou study area (or effects study area) was extended outside of the RSA, and was defined as the winter range of the Bathurst caribou herd below the treeline (Figure 8.1-2).

8.1.3.3 Regional Study Area

The RSA was selected to measure the existing baseline conditions at a scale large enough to capture the maximum predicted spatial extent of the combined direct and indirect effects (i.e., zone of influence [ZOI]) from the NICO Project on caribou (Figure 8.1-3). This area is intended to capture effects that extend beyond the immediate NICO Project footprint, such as noise, lights, smells, and other factors that can indirectly affect the environment at a distance. From 2003 to 2006 the RSA for the proposed mine site was 314 square kilometres (km^2) (i.e., the radius was 10 km centered on the proposed mine site). This area was increased in 2007 to 706 km^2 (i.e., the radius was 15 km centered on the proposed mine site) because of increased knowledge about the effects from disturbance on barren-ground and woodland caribou.

For example, studies on the movements of woodland caribou in the boreal forest of Newfoundland near resource extraction industries indicated that caribou avoided mining activities, with avoidance distances of up to 4 km during the summer and 6 km during the late winter, pre-calving, and calving seasons (Weir et al. 2007). Monitoring of wildlife presence and activity near a park road in Alaska did not detect avoidance by caribou or grizzly bears, but fewer moose and dall sheep were observed within 500 metres (m) of the road (Burson et al. 2000); however, an increase in traffic on the road did not change the abundance, distribution, or behaviour of caribou, grizzly bears, moose, or dall sheep. Above the treeline, studies of barren-ground caribou have detected behavioural changes extending 5 to 7 km from the mine (BHPB 2004), and avoidance from 10 to 40 km around major mine developments (Boulanger et al. 2004; Johnson et al. 2005; Golder 2008a, b; Boulanger et al. 2009). More recent analysis has suggested that caribou are 4 times more likely to occur in areas greater that 11 to 14 km from the Ekati-Diavik mine complex (Boulanger et al. 2009). For the smaller Snap Lake Mine, caribou tend to prefer areas greater than 6.5 km from the mine, although the measurable avoidance of the mine was weak (Boulanger et al. 2009).

These results suggest that the ZOI in tundra environments may be greater than in forested areas. In addition, the effects on barren-ground caribou occurred during the calving and post-calving periods when animals are likely more sensitive to disturbance. In contrast, most effects on caribou from NICO Project activities will likely occur during the winter and in a forested environment where the geographic extent of noise and visual disturbance should be reduced.



LEGEND

- NICO PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- RAILROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- TREELINE
- CARIBOU STUDY AREA
- REGIONAL STUDY AREA

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

CARIBOU STUDY AREA

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-056-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	JV	27 July 2010	**FIGURE: 8.1-2**
GIS	ANK	25 Feb. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

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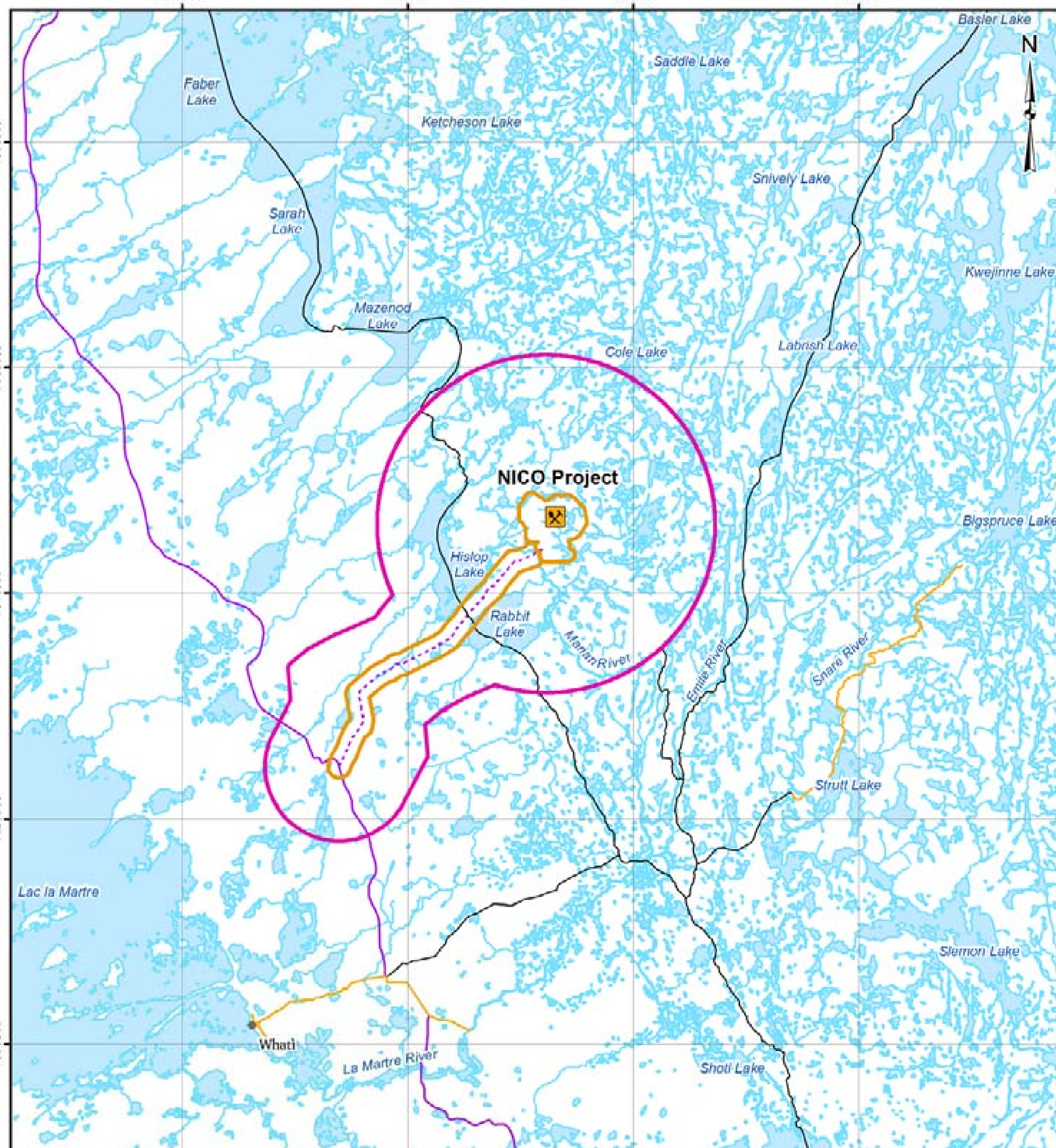

LEGEND

- NICO PROJECT
- POPULATED PLACE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

10 0 10

SCALE 1:500,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

LOCAL AND REGIONAL STUDY AREAS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-019-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	LD	27 Oct. 2008	
GIS	ANK	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.1-3

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The RSA includes a 6.5 km buffer around the proposed road alignment (Figure 8.1-3). The proposed NPAR at the time of baseline studies was a 50 km predicted alignment that joined the NICO site to the winter road between Behchokǫ̀ and Gamètì. Although the NPAR has since been reduced to 27 km, the original 50 km NPAR alignment was evaluated during baseline studies. The TOR (MVRB 2009) stipulates that the assessment for the NICO Project must include all aspects of the 27 km NPAR (e.g., physical footprint and traffic), which will connect the mine to the transportation corridor between Behchokǫ̀ and Gamètì. For the remainder of the transportation corridor (from its origin on Highway 3 to the intersection with the NPAR [approximately 110 km of road]), the DAR need only consider the effects of traffic from the NICO Project on the environment.

The mine RSA includes 2 Level II Ecoregions: Taiga Shield and Taiga Plains. The Taiga Shield Ecoregion is located northeast of Rabbit and Hislop lakes (Ecosystem Classification Working Group 2008), while the Taiga Plains Ecoregion covers the southwest portion of the mine RSA (Ecosystem Classification Working Group 2007). The NPAR is located primarily within the Taiga Plains ecoregion and is more heavily treed than the mine RSA (Figure 8.1-3). In the summer of 2008 a fire burned approximately 10% of the mine RSA.

8.1.3.4 Local Study Area

The LSA boundary for the proposed mine site and NPAR was defined by the expected spatial extent of the immediate direct (e.g., NICO Project footprint) and indirect effects (e.g., dust deposition) from the NICO Project on surrounding soil, vegetation, and caribou (Figure 8.1-3). The LSA for the anticipated mine site was defined as a 500 m buffer around the NICO Project Lease Boundary. The LSA for the NPAR was a 1000 m buffer on either side of the anticipated right-of-way.

The mine LSA contains habitat that is characteristic of regional habitat conditions and vegetation that is typical of the Taiga Plains and Taiga Shield Ecoregions. Most habitat types are equally represented within the mine LSA and RSA; however, coniferous spruce, treed fen, marsh/graminoid fen, and deep water habitats are more common within the mine RSA, than the mine LSA. Bedrock-open conifer habitat is more common within the mine LSA than the mine RSA. Habitat conditions in the NPAR LSA are characteristic of regional habitat conditions; however, the NPAR LSA is more heavily treed than the mine LSA.

8.1.4 Content

The general organization of this KLOI is outlined in Table 8.1-3. To verify that the contents of the TOR are addressed in this report, a table of concordance that cross-references the TOR to the information and location in this DAR is contained in Table 8.1-1.

Table 8.1-3: Key Line of Inquiry: Caribou and Caribou Habitat Organization

Section	Content
Section 8.1	**Introduction** – Provides an introduction to the caribou KLOI by defining the context, purpose, scope, and study areas, and providing an overview of the KLOI organization
Section 8.2	**Summary** – Provides a plain language summary of the current state of caribou populations and the predicted incremental and cumulative effects to caribou from the NICO Project and other developments, relative to natural factors that influence caribou . Related effects to the people that rely on caribou as a resource are also summarized.
Section 8.3	**Existing Environment** – Provides a summary of baseline methods and results for caribou

Table 8.1-3: Key Line of Inquiry: Caribou and Caribou Habitat Organization (continued)

Section	Content
Section 8.4	**Pathway Analyses** – Provides a screening level assessment of all potential pathways by which the Project may influence caribou after applying environmental design features and mitigation that reduce or eliminate Project-related effects
Section 8.5	**Effects to the Abundance and Distribution of Caribou** – Provides a detailed assessment of the effects on caribou populations
Section 8.6	**Residual Effects Summary** – Summarizes the effects on caribou that are predicted to remain after applying environmental design features, mitigation, and reclamation
Section 8.7	**Residual Impact Classication** – Describes methods used to classify residual effects, and summarizes the classification results.
Section 8.9	**Environmental Significance** – Provides a discussion of the environmental significance of the predicted impacts on caribou
Section 8.10	**Uncertainty** – Provides a discussion of the sources of uncertainty related to predicting effects on caribou.
Section 8.11	**Monitoring and Follow-up** – Summarizes the objectives of the proposed monitoring and follow-up programs used to test the predicted effects, mitigation, and reclamation on caribou.

In addition to the content included in this KLOI, Annex D: Wildlife Baseline Report provides additional detailed baseline information for caribou. Section 18: Biophysical Environment Monitoring and Management Plans provides additional detailed monitoring and follow-up program information.

8.2 Summary

The NICO Project is approximately 160 km northwest of Yellowknife in the NWT. The NICO Project is located within the Marian River drainage basin, approximately 10 km east of Hislop Lake, and 50 km northeast of Whatì and 70 km south of Gamètì. Other communities include Behchokǫ̀, approximately 85 km southeast of the NICO Project, and Wekweètì, located approximately 140 km northeast of the NICO Project.

This section of the DAR addresses the NICO Project’s predicted direct and indirect effects on the Bathurst caribou herd within their winter range below the treeline. It includes an assessment of potential behavioural changes resulting from NICO Project-related components and associated activities, including sensory disturbance, and effects on foraging, resting, and caribou movements within the winter range. It also includes the specific effects that changes in caribou abundance and distribution would have on the social, cultural, and economic well-being of residents in the region.

The impact assessment evaluates all NICO Project phases, including construction, operation, and closure and reclamation. The NICO Project includes the anticipated mine site (e.g., Camp, Open Pit, Co-Disposal Facility, and waste treatment plant) and the 27 km long NICO Project Access Road (NPAR). NICO Project-specific (incremental) and cumulative effects have been incorporated throughout this section. Given the size of the Bathurst herd’s winter range, the effects from the NICO Project must be considered in combination with other developments, activities, and natural factors that influence caribou abundance and distribution. The winter range of the Bathurst herd below the treeline is 211 821 km^2, which contained a maximum of about 30 active developments (e.g., exploration camps, staging area, and communities [Yellowknife, Behchokǫ̀, Whatì, Wekweètì, and Gamètì), plus existing winter roads and historic remediated and non-remediated sites (e.g., Colomac and Rayrock mines) during the baseline period.

The migratory movements of the Bathurst herd can extend over much of the NWT, Nunavut, and northern Saskatchewan, where many communities rely on caribou as an important natural resource. Satellite and GPS collar data from 1996 to 2009 showed that the Bathurst herd has the greatest likelihood of interacting with the NICO Project. The NICO Project is located in the midst of a broad area that caribou use during the winter. The NICO Project is not located near the calving grounds of barren-ground caribou herds.

Barren-ground caribou have an important social, cultural, and economic value for the people and communities living in the Canadian Arctic. Aboriginal people have a strong connection with caribou, and rely on the animals for food, clothing, and cultural wellness. Caribou also influence the landscape through their movements and foraging, and provide food resources for predators and scavengers such as wolves, grizzly bears, wolverines, and foxes. The Bathurst herd is currently listed as sensitive by the Working Group on General Status of NWT Species (ENR 2010a); however, they are not listed federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2009).

Pathway analysis identified and assessed the issues and linkages between caribou and the NICO Project components and activities. It was determined that 4 pathways were likely or highly likely to lead to negative residual effects on caribou and human use of caribou. These pathways were further analyzed and assessed for their significance on the persistence of caribou.

- Direct loss and fragmentation of habitat from the physical footprint of the NICO Project may alter caribou movement (i.e., distributions) and behaviour, and affect the carrying capacity of the landscape to support populations.
- Sensory disturbance (e.g., presence of buildings, people, lights, smells, and noise) from the NICO Project changes the amount of different quality habitats, and alters movement and behaviour, which can influence survival and reproduction.
- Change in energetic costs from disturbance and displacement, which can influence survival and reproduction.
- Improved access for harvesting can affect caribou population size.

The total area of the NICO Project footprint (including the NPAR) is estimated to be 485.4 hectares; however, because the NICO Project Lease Boundary was used in the analyses, and the width of the NPAR had to match the raster cell size (200 m) in the land cover classification, the estimated NICO Project footprint used in the assessment was 1860 ha, which is the size of the Project Lease Boundary and width of the NPAR combined. This footprint area represents less than 0.1% of the winter range (study area).

Comparison of 2010 baseline and predicted NICO Project landscapes indicated that habitat-specific incremental changes from the NICO Project footprint were less than 0.1%. The cumulative direct disturbance to the study area from the NICO Project and other previous, existing, and future developments is predicted to be less than 0.5% relative to reference conditions. This change is well below the 40% threshold value identified by numerous studies for habitat loss as being associated with declines in bird and mammal species, and should have a negligible impact on caribou.

The pathways for effects from changes in habitat quality, movement, and behaviour include influences from noise and the presence of people, vehicles, smells, lights, and NICO Project infrastructure. Noise will be generated by mobile and stationary mining equipment, blasting, and aircraft. In general, it is predicted that noise will reach background levels distances about 3.3 km from the mining operation (Appendix 8.III; Table 8.III.9-2).

The combination of direct (physical footprint) and indirect (noise and other sensory disturbances) effects can create a ZOI around a mine site that can change the behaviour and occurrence of caribou. Studies around some established diamond mines in the NWT have shown that caribou are more likely to occur further from the mine than closer to it. The ZOI varies in size among mines and years, but appears to range from about 10 to 30 km from a mine site. The ZOI appears to be larger for mines with a large footprint and higher levels of activity, and smaller for smaller mines, and developments located in the forest.

Incremental local and regional effects from the NICO Project, roads, and other developments can accumulate together to influence the quality of available habitat and the number of animals that the landscape can support (i.e., carrying capacity). Models showed that the majority of good and high quality habitats lost to development occurred prior to 2006. In 2006, 5.1% of habitats in the Bathurst winter range were affected by development when compared to pre-disturbance (reference) conditions. As a result of a decline in the number of active exploration sites on the landscape the area of high quality habitat increased from 2006 to 2010. Relative to reference conditions, cumulative impacts from the NICO Project and previous, existing, and reasonably foreseeable future developments are expected to reduce good and high quality caribou habitat by 6.1% (low impact).

During construction, approximately 2200 truck loads will be delivered to the NICO site during the winter road season. This amounts to approximately 63 return trips per day over an average 70 day (10 week) winter road season. During operations, an estimated 5 to 9 trucks per day are anticipated to travel along the NPAR and Proposed Tłįchǫ Road Route. Noise from the NPAR and existing winter roads will diminish to background noise levels within 0.9 km. The potential noise effects associated with existing winter roads and the NPAR during construction are temporary (limited to 8 to 12 weeks). During operations, noise from vehicles associated with NICO Project along the NPAR and Proposed Tłįchǫ Road Route will occur year-round. Although there is potential for trucks to alter caribou movement and behaviour, the effects should be within the range of baseline conditions (low impact).

Another objective of the effects analysis was to assess the ‘energy’ implications of encounters with developments on body weight in female caribou and on their ability to produce a calf in the spring. In addition, severe weather conditions (e.g., hard and deep snow, freezing rain) during the northern migration to the calving grounds were also analyzed for the effects on the birth weight of the calf and spring to fall survival of calves. The analysis was used to estimate the relative effects from stresses associated human development activities and severe weather-related factors on autumn calf production (fall calf:cow ratio).

Although human developments during fall and early winter movements in the winter range may affect the caribou population, the effect was estimated to be relatively small compared to weather-related factors. The incremental impact to the energy balance of a female caribou from the NICO Project is predicted to result in a 0.3% (negligible impact) decrease in the fall calf:cow ratio relative to a reference condition. Cumulative impacts to the energy balance of female caribou from encountering 40 disturbance events on the winter range was predicted to decrease the fall calf:cow ratio by 7.1% (low magnitude) relative to a reference condition. In contrast, decreases in the calf:cow ratio of 13.2% (moderate impact) and 26.6% (high impact) were predicted for moderately severe and severe spring conditions, respectively; however, the frequency of impacts on the population from moderately severe and, in particular, severe spring conditions is not expected to occur very often.

With the development of the NPAR and Proposed Tłı̨chǫ Road Route, hunters would be able to make more use of vehicles (including snow machines) to access areas in the winter range. Fortune will not permit hunting at the NICO Project, or by its staff or contractors on the NPAR road while travelling to and from the site. Thus, people at site will not benefit from increased access to the region for the harvesting of caribou. The number of caribou harvested in the region from improved access due to the NPAR and the Proposed Tłı̨chǫ Road Route is predicted to be similar to or slightly exceed baseline harvesting values (moderate impact).

The duration of incremental and cumulative impacts from the NICO Project on caribou populations and distribution, and traditional and non-traditional use of caribou for the majority of pathways is anticipated to be reversible over the long-term (26 to 31 years [approximately 2 to 3 caribou life spans]). For the purposes of the assessment and to be conservative, the duration of impacts from increased access associated with the NPAR and Proposed Tłı̨chǫ Road Route is expected to be permanent. Permanent disturbance to 84 ha within the NICO Project footprint are expected to be irreversible within the temporal boundary of the assessment. There is a moderate degree of uncertainty associated with these predictions, which is primarily related to the duration of impacts and the variability inherent to long-term predictions in ecological systems. Confidence in the predictions is based on the consistent low effect sizes (i.e., magnitudes of change) that were determined from the incremental and cumulative effects analyses from changes in habitat quantity, quality, and energy balance on caribou.

The weight of evidence from the analysis of the primary pathways predicts that the incremental and cumulative impacts from the NICO Project and other developments should not have a significant negative influence on the resilience and persistence of the Bathurst caribou population. Most of the incremental and cumulative impacts from development were predicted to be negligible to low in magnitude and reversible. The persistence of caribou herds during large fluctuations in population size indicates that the species has the capability to adapt to different disturbances and environmental selection pressures. Migration routes and survival and reproduction rates appear to have the flexibility to respond to changes through time and across the landscape. This resilience in caribou populations suggests that the impacts from the NICO Project and other developments should be reversible and not significantly affect the future persistence of caribou populations. Subsequently, cumulative impacts from development also are not predicted to have a significant adverse affect on continued opportunities for use of caribou by people that value the animals as part of their culture and livelihood.

8.3 Existing Environment

8.3.1 Methods

8.3.1.1 Review of Regional Effects Monitoring and Research Programs

A literature review of all available information on the effects of disturbance (operating mines within the annual range of the Bathurst herd in particular) on caribou was completed. Monitoring reports from current mining operations in NWT (e.g., Diavik Diamond, Ekati Diamond, and Snap Lake mines), scientific publications, and government reports were reviewed. Available traditional knowledge reports were also reviewed and the information was included in the analysis, where applicable.

8.3.1.2 NICO Project Baseline Study

Caribou have a significant social, cultural, and economic value for the people and communities living in the Canadian Arctic. Aboriginal people have a strong connection with caribou, and rely on the animals for food, clothing, and cultural wellness. Caribou also influence the landscape through their movements and foraging, and provide food resources for predators and scavengers such as wolves, grizzly bears, wolverines, and foxes. As a result, the Bathurst, Ahiak, and Bluenose East herds are listed as *sensitive* (ENR 2010a). The Bathurst, Ahiak, and Bluenose East herds are not listed federally (COSEWIC 2009; *SARA* 2009).

Baseline studies on caribou and caribou habitat were completed within the mine LSA and RSA, and the NPAR LSA and RSA from 1998 to 2010. Qualitative data was collected from 1998 to 2002 and quantitative data were collected from 2003 to 2010. In addition, satellite collar data from the Bathurst, Ahiak, and Bluenose East herds were assessed from 1995 to 2009. The objectives of the studies were to estimate the natural range of variation in the following parameters:

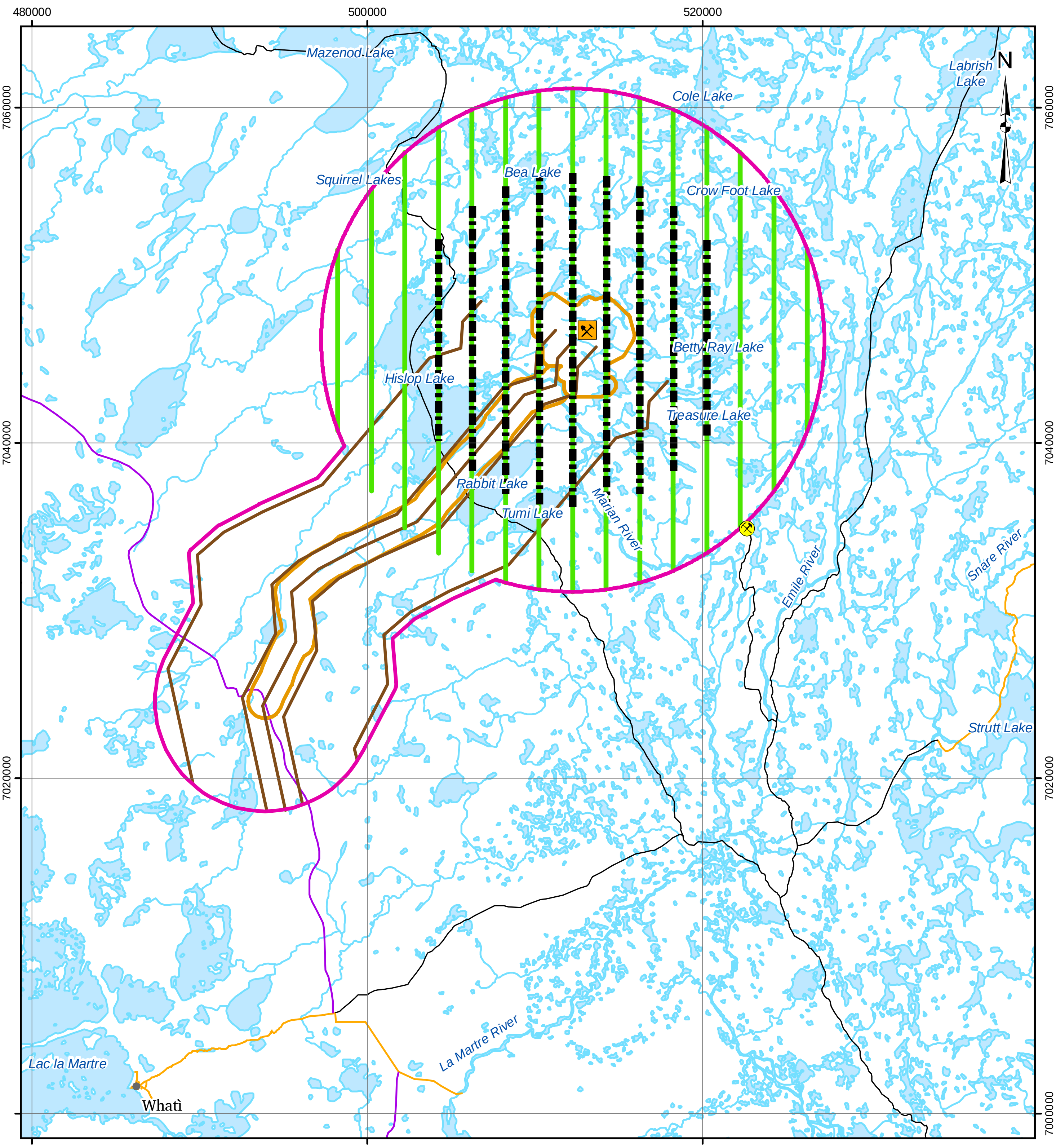
- annual and seasonal occurrence, abundance, distribution, group size, and group composition of barren-ground caribou in the study areas;
- habitat associations, caribou movement patterns, and important movement corridors in the study areas; and
- annual and seasonal likelihood of the Bathurst, Ahiak, and Bluenose East herds interacting with the NICO Project.

Aerial surveys from 2004 to 2010 were divided into 2 components based on the proposed mine site and NPAR study areas (Figure 8.3-1). A record of aerial survey dates is provided in Table 8.3-1. Within the mine RSA, from 2004 to 2006, there were 9 transects oriented in a north-south direction spaced 2 km apart. The survey width was 200 m on either side of the aircraft, which resulted in approximately 16% coverage of the RSA. From 2007 to 2010, there were 15 transects oriented in a north-south direction spaced 2 km apart. The survey width was still 200 m on either side of the aircraft, and resulted in approximately 20% coverage of the RSA.

Table 8.3-1: Dates of Aerial Surveys from 2004 to 2010

Year	Date	Size of Mine RSA	Proportion of Mine RSA Surveyed (%)
2004	26 November, 10 December	10 km radius	16
2005	11 April, 4 May	10 km radius	16
2006	11 April, 6 December	10 km radius	16
2007	11 April, 11 December	15 km radius	20
2008	15 April; 12 December	15 km radius	20
2009	17 December	15 km radius	20
2010	22 March	15 km radius	20

RSA = regional study area; km = kilometre; % = percent



LEGEND

	NICO PROJECT		10 km MINE REGIONAL STUDY AREA TRANSECT (2003-2006)
	RAYROCK MINE		15 km MINE REGIONAL STUDY AREA TRANSECT (2007-PRESENT)
	POPULATED PLACE		PROPOSED NICO PROJECT ACCESS ROAD TRANSECT
	EXISTING ALL-WEATHER ROAD		LOCAL STUDY AREA
	EXISTING WINTER ROAD		REGIONAL STUDY AREA
	PROPOSED TŁĮCHǪ ROAD ROUTE		
	WATERCOURSE		
	WATERBODY		

10 0 10

SCALE 1:325,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

LOCATION OF AERIAL SURVEY TRANSECTS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-020-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	LD	27 Oct. 2008	FIGURE: 8.3-1	
GIS	ANK	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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Within the NPAR RSA from 2004 to 2010, 5 transects were flown parallel to the road alignment with a survey width of 100 m on either side of the aircraft, which covered approximately 9% of the area. A central transect was flown directly over the proposed road alignment, 2 transects were flown approximately 1 km from either side of the alignment, and 2 transects were flown 6 km from either side of the alignment (Figure 8.3-1). The aerial surveys completed for the NPAR RSA followed the entire proposed right-of-way into the mine RSA (Figure 8.3-1); therefore, the area of the NPAR RSA used for aerial survey calculations was different than the area of the NPAR RSA used in other baseline calculations (e.g., snow track densities).

Estimates of caribou group size, instantaneous behaviour (i.e., feeding, bedding, standing, walking, trotting, or running), and group composition (i.e., groups with calves or groups without calves) were collected during the aerial surveys. To augment the instantaneous measure of caribou distribution made during aerial surveys, caribou snow track abundance was also recorded. This provided a measure of caribou distribution over a longer time period (i.e., since the last major snowfall). The estimated annual number, distribution, behaviour, and composition of caribou, as well as caribou habitat selection, were determined for the mine and NPAR RSAs.

Aerial survey data for the NPAR RSA from 2004 to 2010 were pooled because the study area was the same size during all survey years and the wildfire of 2008 did not burn any of the NPAR RSA. Aerial survey data from 2004 to 2006 for the mine RSA were analyzed separately because the surveys were completed within a smaller area than surveys from 2007 to 2010. Aerial survey data from 2007 and 2008 for the mine RSA were analyzed separately from 2009 and 2010 data because the wildfire of 2008 changed the amount of habitats that were available within the mine RSA. Burn, coniferous pine, deciduous aspen-paper birch, marsh/graminoid fen, open bog, shrubland, and treed fen habitats were not included in the mine RSA habitat selection analyses using aerial survey data because each habitat covered less than 2% of the transects sampled in the RSA. Burn was included in the 2009 and 2010 habitat selection analysis as the wildfire in the summer of 2008 burned approximately 10% of the mine RSA. Bedrock-open conifer, burn, deciduous aspen-paper birch, open bog, and shrubland were excluded from the NPAR RSA habitat selection analysis because each habitat type covered less than 2% of the transects sampled in the RSA. Further details regarding the aerial surveys are described in Annex D (Section 5.3.3).

Pellet surveys were completed during the summers of 2005 to 2007 to determine caribou distribution and habitat use within and adjacent to the mine LSA. The surveys were completed during 3 periods over 3 years:

- 24 and 25 June 2005;
- 9 to 11 June 2006; and
- 13 and 16 June 2007.

Caribou pellets, to determine pellet group abundance, were counted along twelve, 500 m long transects in 2005 and 2006, and five 500 m long transects in 2007. Seventeen transects were surveyed in total, of which 14 were in the mine LSA. Further details regarding the pellet surveys are described in Annex D (Section 5.3.3).

In 2005, 2008, and 2009 winter track surveys were completed to determine the relative activity, distribution, and habitat use of caribou within the mine and NPAR study areas. Ten transects (each 1 km long) were established within the mine study areas (i.e., LSA and RSA) in 2005 (Figure 8.3-2). Forty-one transects (range 0.1 to 1.3 km in length) were established within the mine study areas in 2009 (Figure 8.3-2). No winter track surveys were carried out within the mine study areas in 2008. Eleven transects (each 1 km long) were established within the

NPAR study areas in 2005 and 24 transects (each 1 km long) were established within the NPAR study areas in 2008 (Figure 8.3-2). No surveys were completed within the NPAR study areas in 2009. Surveys were completed from 4 to 8 April 2005, 26 February to 1 March 2008, and 8 to 12 March 2009.

Winter track count data for the NPAR RSA from 2005 and 2008 were pooled because the wildfire of 2008 did not burn any of the NPAR RSA. Winter track data of 2005 and 2009 for the mine RSA were analyzed separately because the wildfire of 2008 changed the amount of habitats that were available within the mine RSA. Further details regarding the winter track surveys are described in Annex D (Section 5.3.3).

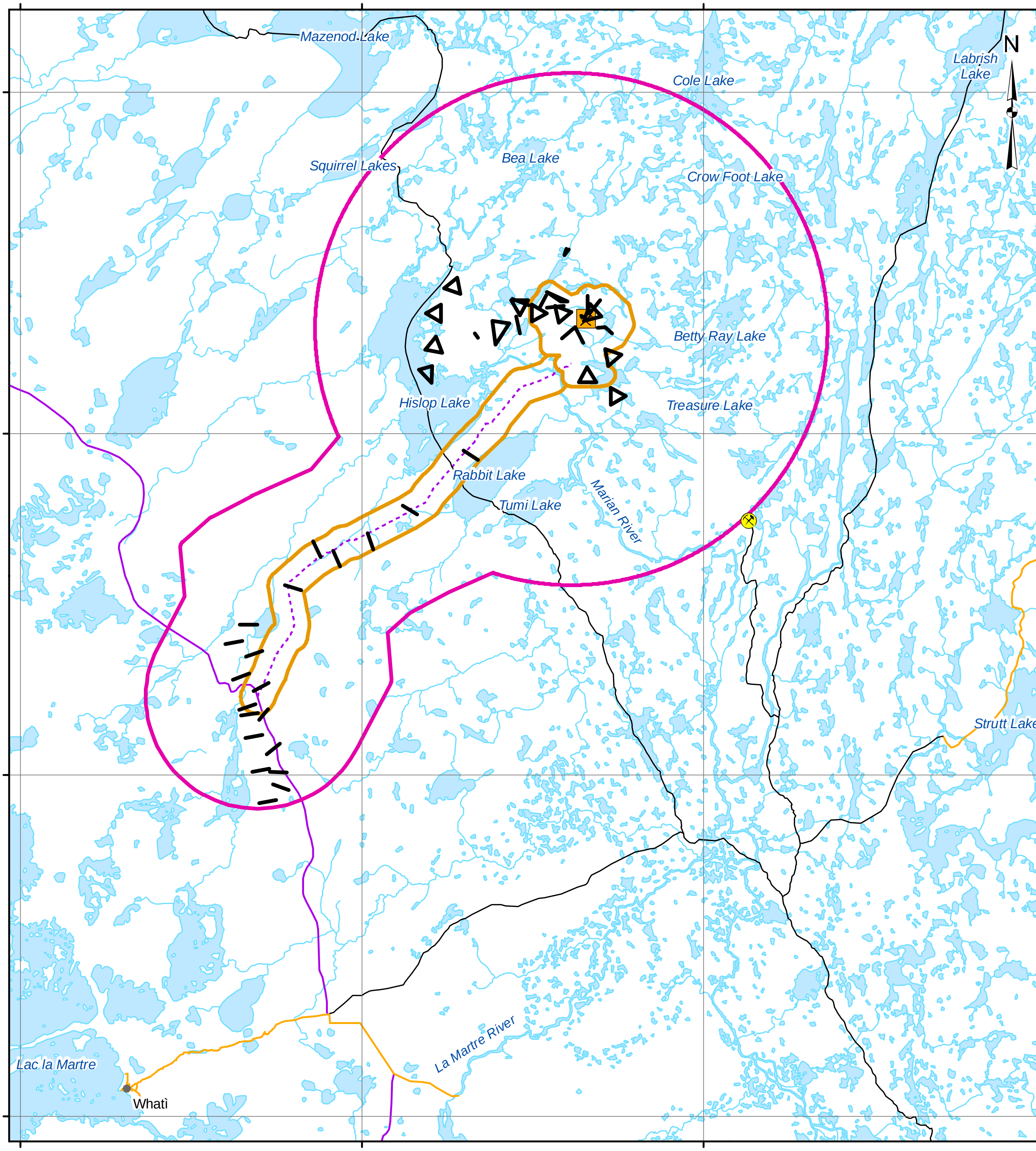
Satellite and GPS collar data (provided by the ENR) suggests that the annual home range of 3 barren-ground caribou herds may overlap the NICO Project:

- Bathurst herd;
- Queen Maud Gulf or Ahiak herd; and
- Bluenose East herd.

Annual and seasonal ranges were calculated for satellite and GPS-collared caribou in the Bathurst, Ahiak, and Bluenose East herds using data from 1995 to 2009. Annual and seasonal ranges for the Bathurst herd were calculated based on collar data from 1 January 1995 through 30 April 2009. The temporal extent of satellite-collared data for the Bluenose East herd is from 1 January 1996 through 31 October 2008, and for the Ahiak herd is from 1 January 2001 to 31 October 2008. Caribou distribution for each herd was classified into 6 periods based on inspection of annual movements of satellite collared caribou (ENR 2009b) as follows:

- northern migration (1 to 31 May);
- calving (1 to 15 June);
- post-calving aggregation (16 June to 1 July);
- summer dispersal (2 July to 31 August);
- rut and fall migration (1 September to 31 October); and
- winter dispersal (1 November to 30 April).

Further details regarding the satellite collar data are described in Annex D (Section 5.3.3).



LEGEND

- NICO PROJECT
- RAYROCK MINE
- POPULATED PLACE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHQ ROAD ROUTE
- WATERCOURSE
- WATERBODY
- WINTER TRACK TRANSECT (2005, 2008, 2009)
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

10 0 10

SCALE 1:325,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

LOCATION OF TRANSECTS FOR WINTER TRACK SURVEYS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-022-GIS				
PROJECT No. 09-1373-1004		SCALE AS SHOWN		REV. 0
DESIGN	LD	27 Oct. 2008	FIGURE: 8.3-2	
GIS	ANK	03 Apr. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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8.3.2 Results

8.3.2.1 Review of Regional Effects Monitoring and Research Programs

8.3.2.1.1 Population Status and Distribution

8.3.2.1.1.1 Barren-ground Caribou

All herds of barren-ground caribou present in the NWT have declined over the past 10 years (NWT Species Monitoring Infobase 2009, internet site; BQCMB 2008, 2009; but see Fisher et al. 2009), and 34 of the 43 major herds world-wide are in decline (Vors and Boyce 2009). As a result, all herds of barren-ground caribou in the NWT (with the exception of Peary caribou) are ranked as '*sensitive*' in the NWT (ENR 2010a). Barren-ground caribou are not listed under COSEWIC (2010, internet site) or *SARA* (2011, internet site). 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; ENR 2009b; ENR 2011a). 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; ENR 2011a), the exact mechanisms responsible for generating these population cycles are unknown.

Recent surveys indicate that the Bathurst herd size has decreased by approximately 93% between 1986 and 2009 (from approximately 472 000 individuals to 31 900 individuals) (Fisher et al. 2009; ENR 2009c). This herd appears to be stabilizing based on the survey completed in 2010 (ENR 2011a). The Qamanirjuaq herd's population estimate was 345 000 individuals in 2008, which is down from the estimate of 496 000 individuals in 1994 (a 30% decrease) (BQCMB 2009). The Porcupine herd has experienced a 23% decrease between 1992 and 2001 (from 160, 000 individuals to 123 000 individuals) (NWT Species Monitoring Infobase 2009, internet site). The Cape Bathurst, Bluenose East, and Bluenose West herds, combined, have declined from 122 000 individuals in 1992 to 86 400 individuals in 2006 (a 29% decrease) (NWT Species Monitoring Infobase 2009, internet site); however, these herds seem to be stable or increasing based on surveys completed in 2010 (ENR 2011a). A recent post-calving survey of the Bluenose East herd in 2010 estimated that the population has increased to 98 600 animals (based on post-calving photographic survey) (ENR 2011a). Although a population survey has not been successfully carried out on the Beverly herd since 1994, reconnaissance surveys in 2008 recorded 93 females on the calving grounds; this is down 98% from the 1994 population census of 5737 females (BQCMB 2008). The status of the Ahiak herd since the mid-1990s is unknown, but given the synchronicity in population cycles of barren-ground caribou, population decreases in this herd are suspected. Reduced fecundity and adult survival have been cited as contributing factors to these declines in herd size (Boulanger and Gunn 2007; Nishi et al. 2007).

Using modelling techniques and data collected from 1996 to 2003, Boulanger and Gunn (2007) estimated annual survival rates of caribou: female adult = 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. Modelling also showed that survival rates of adult females were relatively constant from 1986 to 2006, but that fecundity and calf survival declined during this period. Furthermore during surveys on the calving grounds of the Beverly and Qamanirjuaq herds, for every 100 cows there was estimated to be 15 and 20 calves, respectively, which is well below the usual 80 calves per 100 cows.

The links between demographic variables (e.g., adult and calf survival), environmental factors (e.g., food quality and quantity, insects, hunting, and development), and population growth are not well understood. Although direct losses of habitat (e.g., total mining footprint) are relatively small, and likely have marginal influences on the carrying capacity of the landscape (Johnson et al. 2005), industrial development has the potential to disrupt movements and reduce availability of high-quality habitat. For example, Johnson et al. (2005) showed that Bathurst caribou avoided areas of industrial development, particularly during post-calving movements. Other studies have suggested that caribou can adjust their behaviour (e.g., by feeding more in non-disturbed areas) to accommodate some disturbance (e.g., Colman et al. 2001).

However, if avoidance behaviour is related to a disturbance response, then there may be implications of auditory or visual disturbance at the population level, such as reduced recruitment. If animals are exposed to multiple disturbance events, then there may be energy costs (e.g., Tyler 1991). A single encounter with disturbance (i.e., loud noise) is unlikely to cause adverse energy consumption by an animal; however, the effect of exposure to disturbance should be proportional to the number of times an animal encounters disturbance events (Bradshaw et al. 1998).

Natural factors, such as insect pest outbreaks and climate change may also have an important role in population dynamics, and their interacting effects with habitat requirements may confound any perceived relationships with human activity (e.g., Tews et al. 2007). 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 Dene Elders and Land-Users et al. 2005). 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 wildfire 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 impact caribou populations and distributions (Sharma et al. 2009). Climate change is also likely to lead to earlier plant emergence. As plants are most nutritious 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. Therefore, as the climate becomes warmer, caribou migrations may become out of sync with plant emergence, which may lead to a decline in reproductive success, as has been shown in Greenland (Post and Forchhammer 2008).

Other possible causes of recent reductions in herd size include commercial and subsistence hunting (Boulanger and Gunn 2007). Case et al. (1996) estimated that between 14 500 and 18 500 Bathurst caribou were harvested annually from 1982 to 1995. Based on the Dogrib Harvest Study, Boulanger and Gunn (2007) estimated that, on average 6.7% of bulls (range = 3.0 to 9.2%) and 4.1% of cows (range = 1.4 to 7.0%) were harvested annually from 1988 to 1993 (based on estimated population size); however, demographic models suggest that reduced levels of hunting generated only a slight increase in adult survival (3%), which was not enough to produce positive population growth (Boulanger and Gunn 2007).

In addition to the above-mentioned environmental and anthropogenic external factors, density dependence may be an important factor in the population dynamics of barren-ground caribou (Tews et al. 2007). Density dependence occurs when the growth rate of a population decreases as its density increases. In some 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 and Gunn (2007), clearly show cyclical trends in abundance of Bathurst caribou from 1976 to 2009. Thus, density-dependence is one possible mechanism that may underlie recent (beginning in the 1990s) declines in population size (Figure 8.3-3).

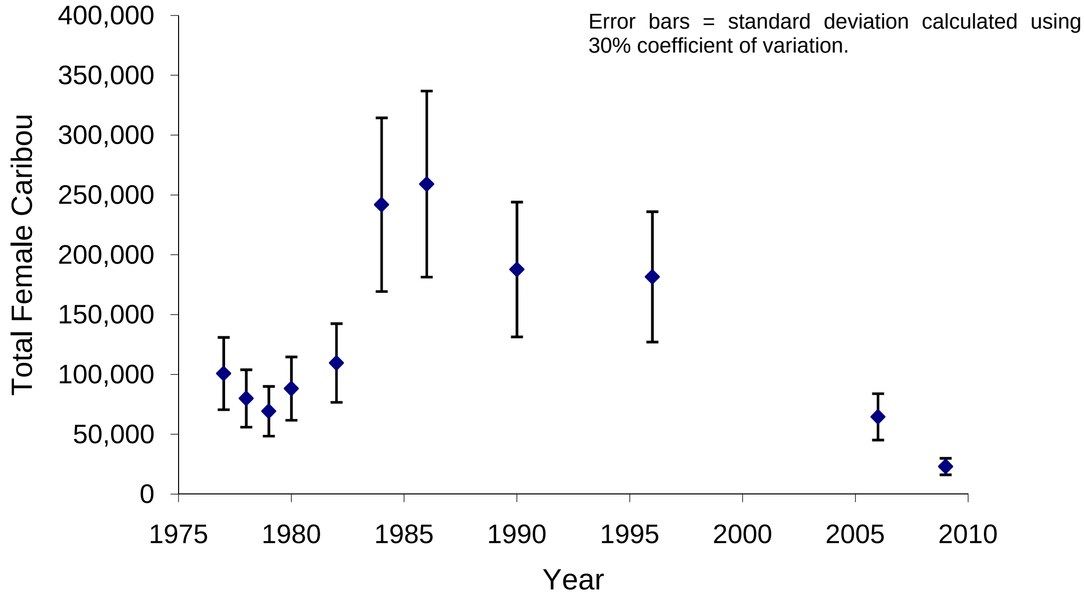


Figure 8.3-3: Temporal Trend in Number of Female Caribou from the Bathurst Herd, 1976 to 2009

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

Variation in barren-ground caribou movement and distribution occurs within and among years, and for different populations. Caribou population numbers naturally fluctuate, and caribou expand their range when populations increase and limit their distribution when populations decrease (Banfield and Jakimchuk 1980; Bergerud et al. 1984; Heard and Calef 1986). The annual calving ground is the most predictable part of the annual home range; however, over decadal periods the annual calving grounds may shift across the landscape (Gunn et al. 2002). Although the precise timing and location of barren-ground caribou movements between winter ranges and calving grounds are unpredictable, general corridors and the broad timing of movements are known. Caribou movements are generally classed into 6 periods (biological seasons) based on satellite-collared caribou data and their position on the landscape (ENR 2009b).

Barren-ground caribou migrate from wintering grounds in the boreal forest, north to calving grounds in the tundra. Pregnant cows lead the northern migration in late winter/early spring, followed by juveniles and bulls (Miller 1992). After calving, cows and calves begin to migrate back to the winter range. As spring turns into summer, the cows meet up with the bulls that have continued to travel north (ENR 2009b). In August and September, the caribou move across the tundra towards the treeline. The rut occurs in October, and may last for 2 to 3 weeks. The local distribution of barren-ground caribou changes constantly during the winter as they search for places where the food is abundant and the snow is the shallowest (ENR 2009b). When spring arrives, the caribou once again begin their migration to the calving grounds.

There is considerable evidence to suggest that caribou herds respond to diamond mine developments by changing their distribution (Boulanger et al. 2004; Golder 2005, 2008a, b; Johnson et al. 2005; BHPB 2007). These studies found a significant positive relationship between the occurrence of caribou and distance to the mine. In other words, caribou were more likely to occur further from the mine than closer to the mine. This reduction in caribou occurrence has been called the ZOI. At the Diavik Diamond Mine, the ZOI ranged from 16 to 36 km, and was on average 29 and 23 km for the northern and post-calving migrations, respectively (Golder 2008a). Although there has been no temporal increase in the size of the ZOI, it greatly exceeds the original impact predictions which predicted a ZOI between 3 and 7 km (DDMI 1998). For the Snap Lake Mine, the ZOI ranged from 10 to 28 km and was on average 19 km and 17 km for the northern and post-calving migrations, respectively. During the post-calving migration there was some indication that the ZOI increased from baseline through to current construction (Golder 2008b).

Resource selection models based on satellite-collared barren-ground caribou, after controlling for vegetation, found that mines and other major developments might have a ZOI of up to 33 km (Johnson et al. 2005). A comparative study using satellite and aerial survey caribou locations around 3 mines in the NWT (Diavik, Ekati, and Snap Lake), estimated ZOI ranging from about 16 to 50 km; aerial survey-based ZOI were generally smaller than those generated from satellite data (Boulanger et al. 2004). The high level of variability in the estimates for the ZOI from projects is in part due to the highly variable annual distribution of caribou. In addition, variation in the predicted ZOI is likely associated with differences in the size of the mine footprint and level of activity for a project. Habitat and the presence of large lakes also influence the distribution of caribou near mine sites (Golder 2008a, b). More recent analyses have estimated the ZOI to be 11 to 14 km near the Ekati-Diavik mine complex during the operation phase (Boulanger et al. 2009). Habitat selection by caribou was about 4 times higher outside the ZOI in the Lac de Gras area. At the smaller Snap Lake Mine, a weaker ZOI of 6.5 km was detected (Boulanger et al. 2009). Overall the presence of caribou within the mine study areas has been variable among years, but has not declined as mine activity increased (BHPB 2007; Golder 2008a, b). Most studies show that caribou appear to change their distribution and reduce habitat use within approximately 10 to 30 km from a mine site.

8.3.2.1.1.2 Woodland Caribou

Most woodland caribou populations have also declined in recent years (ENR 2009a). The Boreal ecotype of woodland caribou is listed as '*sensitive*' in the NWT (ENR 2010a) and '*threatened*' by COSEWIC (2009) and *SARA* (2009). The Northern Mountain ecotype is '*of special concern*' territorially and federally (COSEWIC 2009; *SARA* 2009; ENR 2010a). Woodland caribou populations occur at low densities (0.03 to 0.12 caribou/km^2) throughout the mid-continent (Stuart-Smith et al. 1997); however, population numbers and trends for woodland caribou in Canada are poorly known. Low densities, large land area, and multiple jurisdictions limit accurate population estimates. The population estimate of woodland caribou in the NWT was between 4000 and 6400 in 2001 (ENR 2009a). The population estimate of the North Slave population of woodland caribou, which occupy the area surrounding the NICO Project, was 700 individuals in 2005 (Government of Canada 2009, internet site). This population estimate was derived from numbers of collared animals in other areas of the NWT, thus the current population trend of the North Slave population is unknown.

Woodland caribou are distributed across the forested and mountainous regions of Canada, reaching the northern limit of their range in the NWT (NWT Species Monitoring Infobase 2009, internet site). Little is known about the status of woodland caribou in the NWT (Dzus 2001). Woodland caribou in the NWT range from the Alberta border north to the tundra, west of Great Bear and Great Slave Lakes (Edmonds and Smith 1991). Woodland caribou do not have definitive calving grounds like barren-ground caribou, although individual females often show fidelity to previous calving sites (Edmonds and Smith 1991; Dzus 2001). Instead pregnant females separate themselves from other caribou for calving.

Woodland caribou are not migratory and remain in forested habitats year round (Dzus 2001; NWT Species Monitoring Infobase 2009, internet site). The woodland caribou rut occurs in early- to mid-October (Edmonds and Bloomfield 1984). In November, woodland caribou disperse into smaller groups throughout their annual home range (Dzus 2001). When snow depth increases, caribou tend to move into areas of higher tree cover since movement and feeding are easier in these areas (Fuller and Keith 1981).

Woodland caribou have also been reported to avoid burned and anthropogenic disturbance areas. Woodland caribou in Newfoundland exhibited avoidance of 4 km surrounding an active mine site (Weir et al. 2007) and 9 km around active logging operations (Schaefer and Mahoney 2007). Burned areas are also avoided, either because of lack of food (i.e., lichen) (Schaefer and Pruitt 1991; Joly et al. 2003) or increased abundance of other ungulates and therefore predators (Environment Canada 2008). Linear corridors, such as roads, are also generally avoided (Dyer et al. 2002); possibly because of increased predator or human presence in these areas (James and Stuart-Smith 2000). It has been suggested that a minimum area of 9000 km^2 of undisturbed forest is needed to sustain populations of woodland caribou (Vors et al. 2007).

8.3.2.1.2 Habitat Selection and Foraging

Habitat selection and barren-ground caribou behaviour 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). During the winter barren-ground caribou will select habitats that have an abundance of lichen (Sharma et al. 2009). The calving season will often find barren-ground caribou in areas of high elevation with sparse vegetation, which likely reduces predation rates (Sharma et al. 2009). During the post-calving season areas with high quality forage (Sharma et al. 2009) and low insect density (Toupin et al. 1996) are selected. Cows with calves play an important role in influencing caribou behaviour because they direct the overall movements of the herd and pass on traditional movement patterns (Curatolo 1975).

Woodland caribou prefer mature to old conifer forests since these habitats contain lichen, which is the caribou's primary winter food source (Dzus 2001). Woodland caribou primarily select peatland-dominated landscapes, such as black spruce bogs and black spruce-tamarack fens, while typically avoiding upland areas; however, caribou will use lichen-rich jack pine stands (Stuart-Smith et al. 1997). Woodland caribou tend to calve in low-lying areas, such as muskeg bogs and fens (Dzus 2001).

Wildfire can alter the availability of forage for caribou inhabiting forested environments (i.e., woodland caribou year-round or barren-ground caribou during the winter). Studies from central Alaska suggest that the depletion in lichen abundance after wildfire changes caribou range use and forces caribou to increase their home range size during the winter (Courtois et al. 2007); however, studies in northern Alberta found no change in caribou range size or use after wildfire (Dalerum et al. 2007). Instead, Dalerum et al. (2007) suggest that caribou occupying large home ranges (i.e., caribou in more northern areas) may be able to use alternative areas within their home ranges to forage for lichen, instead of switching to new, previously unused areas. The severity of a fire may affect woodland caribou populations differently depending on the arrangement of burned and unburned patches that are left after the fire (Environment Canada 2008). The differential effects on woodland caribou habitat quality are related to the effects on forage, the post-disturbance trajectory of burned areas, and the numerical response by predators and competitors. Fire disturbance has been negatively associated with caribou recruitment (Environment Canada 2008) and severe fires may negatively impact woodland caribou since woodland caribou avoid young forests (Schaefer and Pruitt 1991; Dunford 2003; Joly et al. 2003; Dalerum et al. 2007). Barren-ground caribou may avoid recent fires (within 55 years of being burned; Joly et al. 2007) because lichen cover may be reduced to 5%, even after 20 to 35 years of regeneration (Jandt et al. 2008). Traditional knowledge also reports that the frequency and intensity of fire can influence caribou numbers and seasonal ranges (Kendrick et al. 2005).

A wide range of forage plants are used by caribou and food habits vary seasonally (Banfield and Jakimchuk 1980). Caribou are not typically browsers and most of the early winter diet consists of lichens (genera *Cladonia* and *Cladina* spp. preferred) and the green parts of sedges (*Carex* spp.) and horsetails (*Equisetum* spp.) because of their high digestibility and high protein levels (Miller 1976; Case et al. 1996). The consumption of grasses and sedges diminishes over winter, as these plants become less digestible (Kelsall 1968). In late winter, lichens are used extensively, although alder (*Alnus* spp.), birch (*Betula papyrifera*), and willow (*Salix* spp.) may be consumed when other food resources are scarce. Snow characteristics, such as hardness and depth, can influence forage availability and the selection of winter habitat (Case et al. 1996; Dzus 2001). Snow cover, rather than food availability, appears to limit the capacity of winter ranges to support barren-ground caribou. In spring, lichen uplands are the first areas to become snow free, and shrubby lichens become important until new plant growth emerges. Unique habitat features sought out by caribou include mineral licks of frost boils or mud boils, which are primarily mounds of silt and clay (Pruitt 1960).

Lichen provides a good source of energy but it is not rich in protein (Miller 1992). Therefore, in spring and summer, caribou tend to select new plant growth and flowers, which are rich in minerals and protein (Thompson and McCourt 1981; Miller 1992). During the calving season, willow, dwarf birch (*Betula glandulosa*), green alder (*Alnus crispa*), and cotton grass (*Eriophorum* spp.) are consumed as new growth emerges (Fleck and Gunn 1982). Following calving, caribou will move to areas where new vascular plants are more abundant. Willow, forbs, grasses, and sedges become important forage species in summer (Case et al. 1996; Demarais and Krebs 2000). By late summer, the leaves of deciduous shrubs, such as willow, dwarf birch, and bearberry (*Arctostaphylos* spp.*),* form much of the diet (Skoog 1986). In the fall, grasses, sedges, mushrooms, birch, and willow leaves remain important because of the protein content (Miller 1992).

8.3.2.1.3 Specific Mining-Caribou Interactions

Food Waste

Food waste at mines represents a hazard to caribou primarily because improperly handled waste can become an attractant to predators such as bears and wolves, and increase the risk of predation on caribou. The risk of food waste attractants at mines is mitigated by sorting waste, burning all food refuse, regular monitoring of landfills for the evidence of attractants, educating staff about waste sorting and proper disposal, and enclosing waste transfer areas and incinerators (BHBP 2001).

Although waste management and wildlife management practices have been successful at reducing risks to wildlife, attractants are routinely found in landfills at most diamond mines. Most animals and sign observed during these landfill surveys were associated with foxes. Grizzly bears, wolverine, and wolf tracks were occasionally observed (BHPB 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009). At the Snap Lake Mine, there were no reported waste or attractant-related incidents or mortalities from 1999 to 2010 (De Beers 2010). There were no incidents involving black bears, grizzly bears, or wolves. The record at the Snap Lake Mine indicates that the implementation of waste management and wildlife management plans can be effective at limiting the risks of injury and death to wildlife.

Pits and Processed Kimberlite Containment Facilities

Pits represent a potential hazard to caribou. No caribou have been observed falling into pits at the Ekati and Diavik diamond mines (BHPB 2010; DDMI 2010). Although caribou mortalities have occurred near pits and facilities, there have been no confirmed mortalities as a result of interaction with pits or containment facilities. Mortalities associated with containment facilities are presumed to be the result of predation by wolves or bears (BHPB 2006, 2007).

Surveys of the processed kimberlite containment area at the Ekati Diamond Mine have recorded observations of caribou and caribou tracks (BHPB 2006, 2007). In addition, caribou have been observed to bed on and travel over processed kimberlite. No injuries or death of animals have been attributed to the processed kimberlite containment area at either the Ekati Diamond Mine or Diavik Diamond Mine (BHPB 2010; DDMI 2010).

Roads and Airstrips

Caribou mortality due to collisions with vehicles and aircraft is a direct effect from mine and mine-related developments (i.e., winter roads and airstrips). Numerous mitigation policies and procedures are in place at active mines to prevent vehicle collisions with caribou (EBA 2001; BHPB 2010; DDMI 2010; De Beers 2010).

Mitigation includes the following:

- speed limits;
- caribou advisory notification;
- giving wildlife the right-of-way;
- electric fencing, flagging, or inukshuks around airstrips or other hazardous mine structures;
- road closures during periods of high caribou presence;
- employee education;
- careful herding of caribou away from hazards; and
- ploughing snowbanks on winter roads to allow for wildlife crossing.

Caribou have been observed bedding or travelling on roads and airstrips. Road and airstrip traffic mitigation practices and policies appear effective, as no caribou have been killed in vehicle or aircraft collisions at mine sites (BHPB 2010; DDMI 2010; De Beers 2010). The exception is the Tibbitt-to-Contwoyto winter road where 5 caribou were killed by a grocery truck (EBA 2001).

Electric fencing, flagging, and inukshuks have been moderately successful at deterring caribou from airstrips and other mine facilities; however, caribou have become entangled in electric fences. At the Ekati Diamond Mine, 6 caribou have been entangled in the electric fence surrounding the airstrip from 2001 through 2009 and 4 of these animals have died (BHPB 2003, 2005, 2010). At the Diavik Diamond Mine, a caribou became entangled in an electric fence and was killed by a grizzly bear (DDMI 2007).

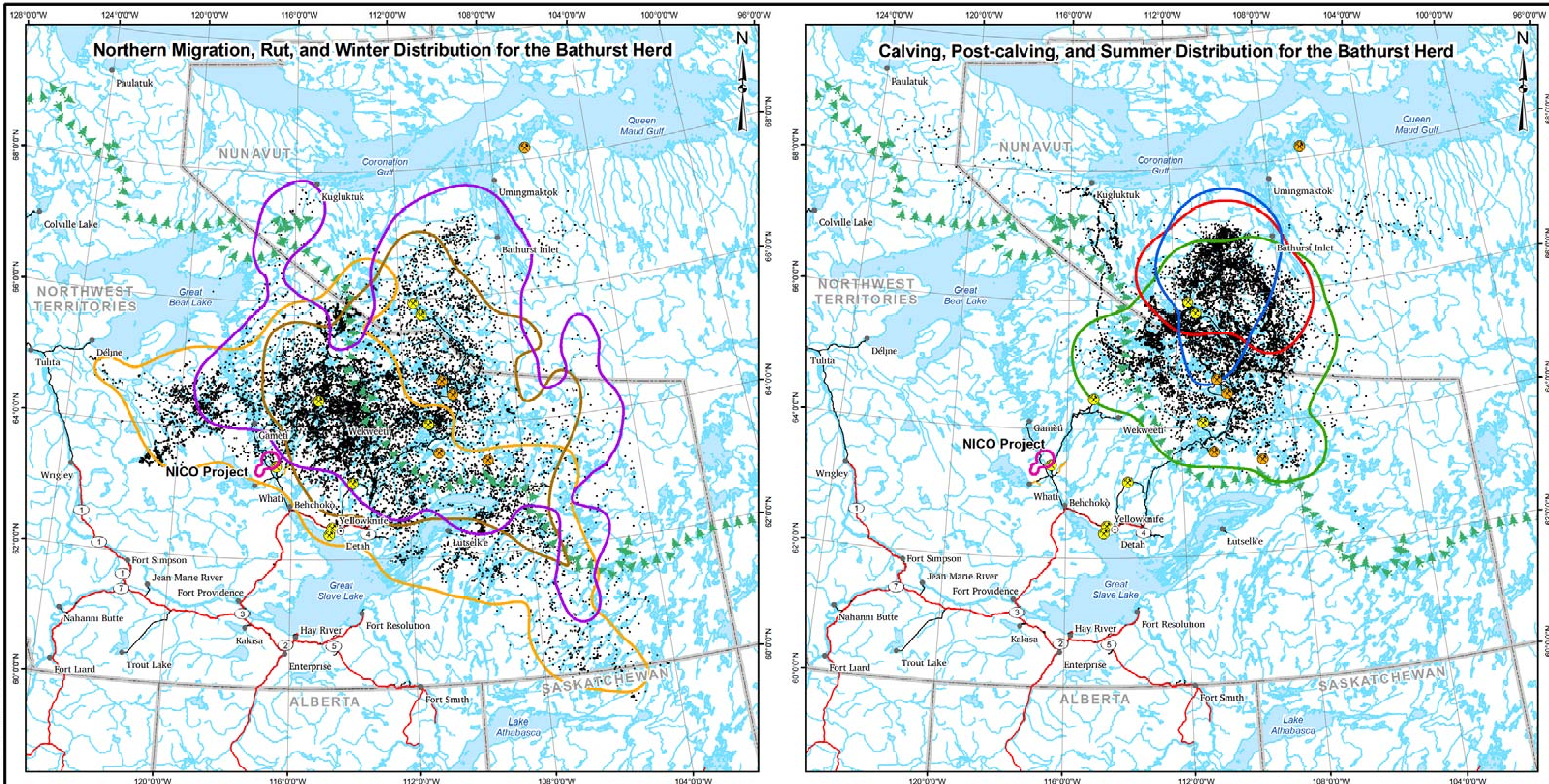
8.3.2.2 NICO Project Baseline Study

8.3.2.2.1 Occurrence of Caribou within the Regional Study Area

The Bathurst caribou herd can range over an area of about 412 000 km^2, extending from Bathurst Inlet to the northern boreal forest (Gunn et al. 2002). The estimated annual range (based on 95% kernel density of data from 1996 to 2009 [Figure 8.3-4]) is 400 435 km^2. Winter distribution extends from the south side of Great Bear Lake to as far south as northern Saskatchewan.

The estimated annual range of the Ahiak caribou herd (based on 95% kernel density from data from 2001 to 2008 [Figure 8.3-5]) is 443 717 km^2. Winter distribution extends from the south side of Queen Maud Gulf to northern Saskatchewan. The estimated annual range of the Bluenose East caribou herd (based on 95% kernel density from data from 2001 to 2008 [Figure 8.3-6]) is 236 375 km^2. Winter distribution extends from the north side of Great Bear Lake to the community of Behchokǫ̀.

The occurrence of barren-ground caribou in the RSA was estimated from the presence of satellite-collared animals from the Bathurst, Ahiak, and Bluenose East herds (Table 8.3-2). The RSA is within the area that is commonly used by wintering Bathurst caribou (Figure 8.3-4). The Ahiak and Bluenose East caribou herds also have the potential to use the RSA during the winter months (Figure 8.3-5 and Figure 8.3-6).



LEGEND

- PROPOSED OR OPERATIONAL MINE
- DECOMMISSIONED MINE
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- BATHURST CARIBOU SATELLITE LOCATION
- TREELINE
- REGIONAL STUDY AREA
- NORTHERN MIGRATION
- RUT
- WINTER
- CALVING
- POST-CALVING
- SUMMER

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Environment and Natural Resources, Government of Northwest Territories, 2010
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE
ANNUAL AND SEASONAL DISTRIBUTION OF SATELLITE-COLLARED CARIBOU FOR THE BATHURST HERD 1996 TO 2010

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-023-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
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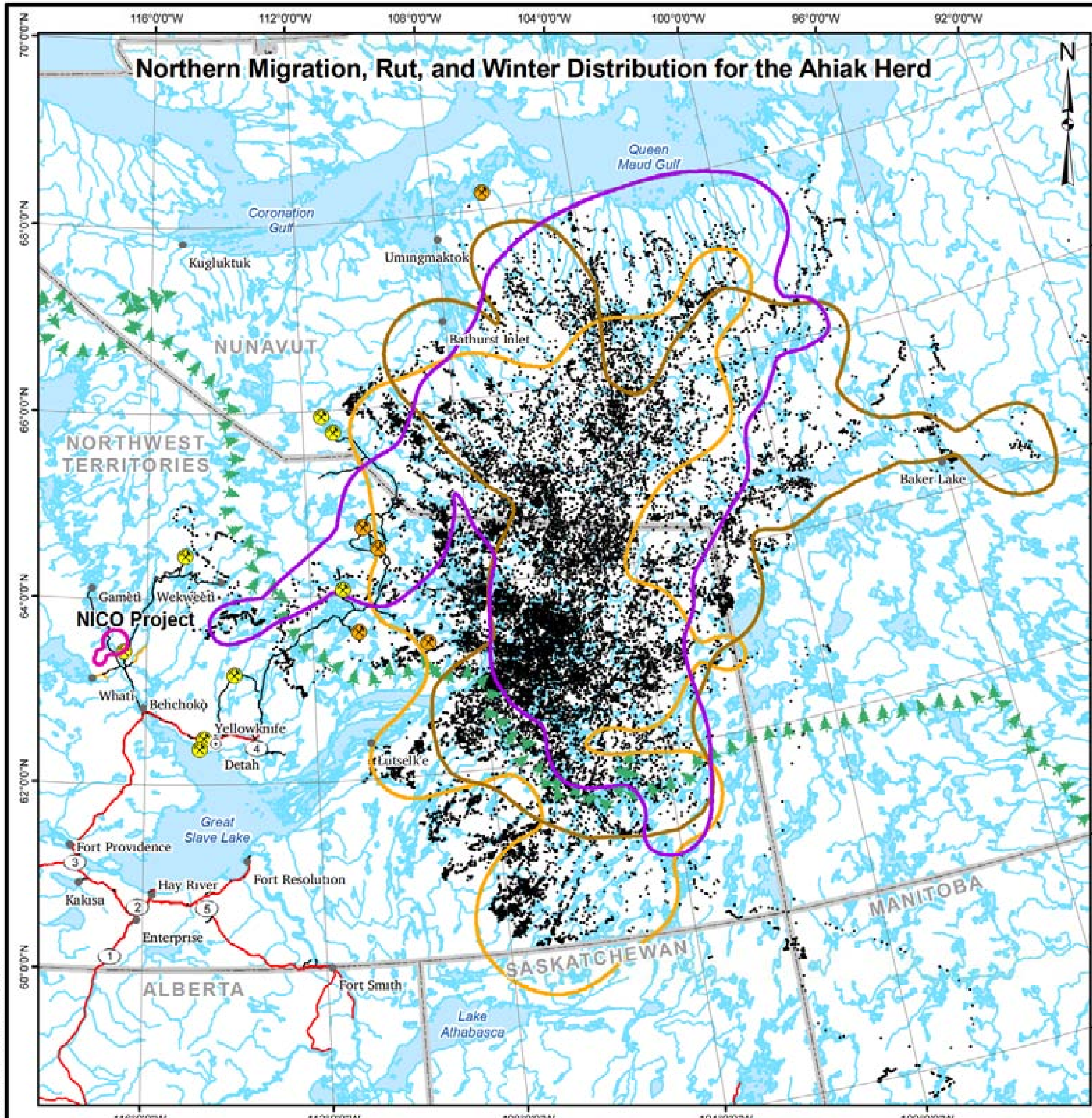
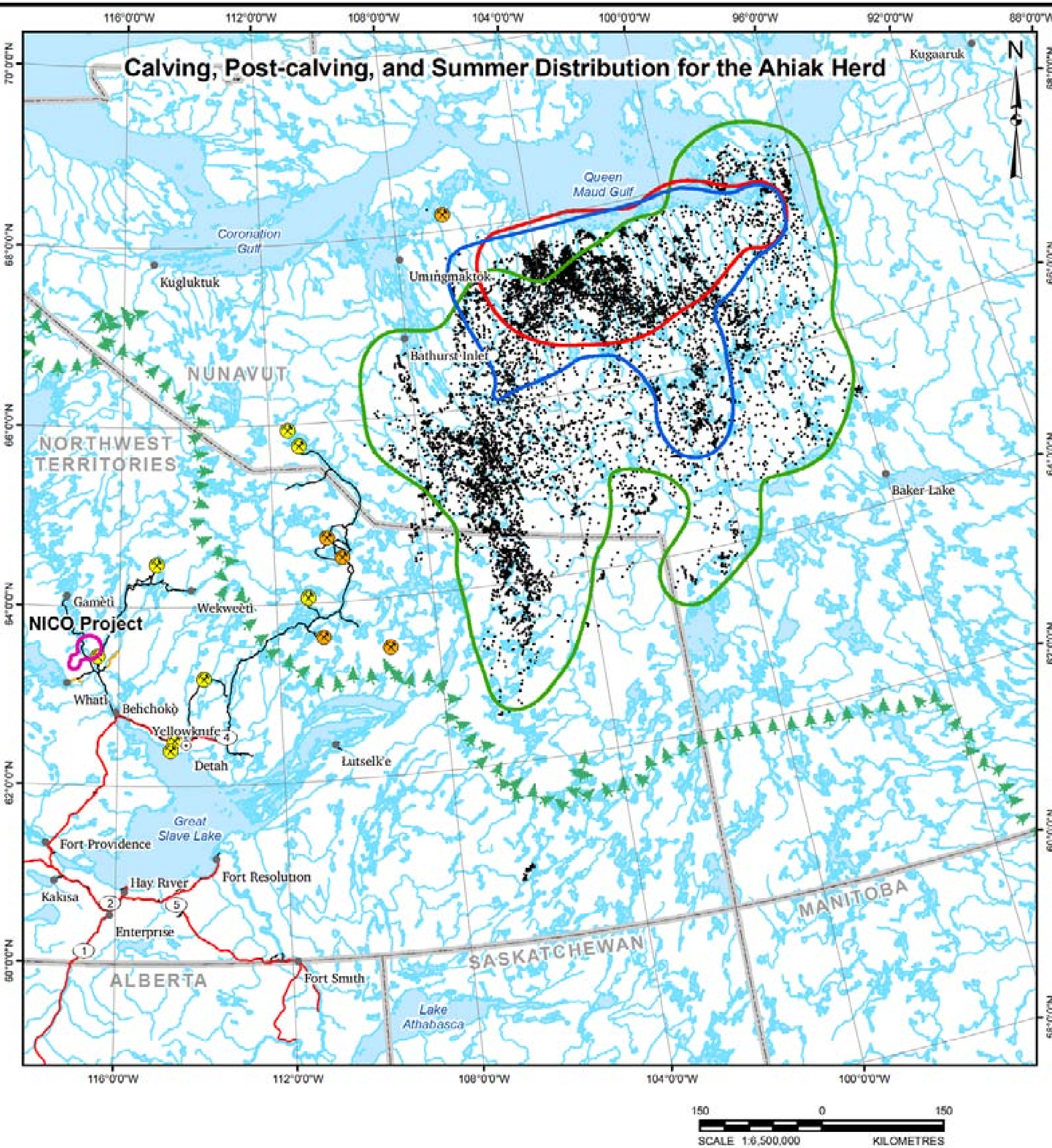
GIS	ANK	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.3-4





LEGEND

- PROPOSED OR OPERATIONAL MINE
- DECOMMISSIONED MINE
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- AHIAK CARIBOU SATELLITE LOCATION
- TREELINE
- REGIONAL STUDY AREA
- NORTHERN MIGRATION
- RUT
- WINTER
- CALVING
- POST-CALVING
- SUMMER

NOTE

Collar Data 2008-2010 is combined Ahiak and Beverly Herds.

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Environment and Natural Resources, Government of Northwest Territories, 2010
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

ANNUAL AND SEASONAL DISTRIBUTION OF SATELLITE-COLLARED CARIBOU FOR THE AHIAK HERD 2001 TO 2010

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-024-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
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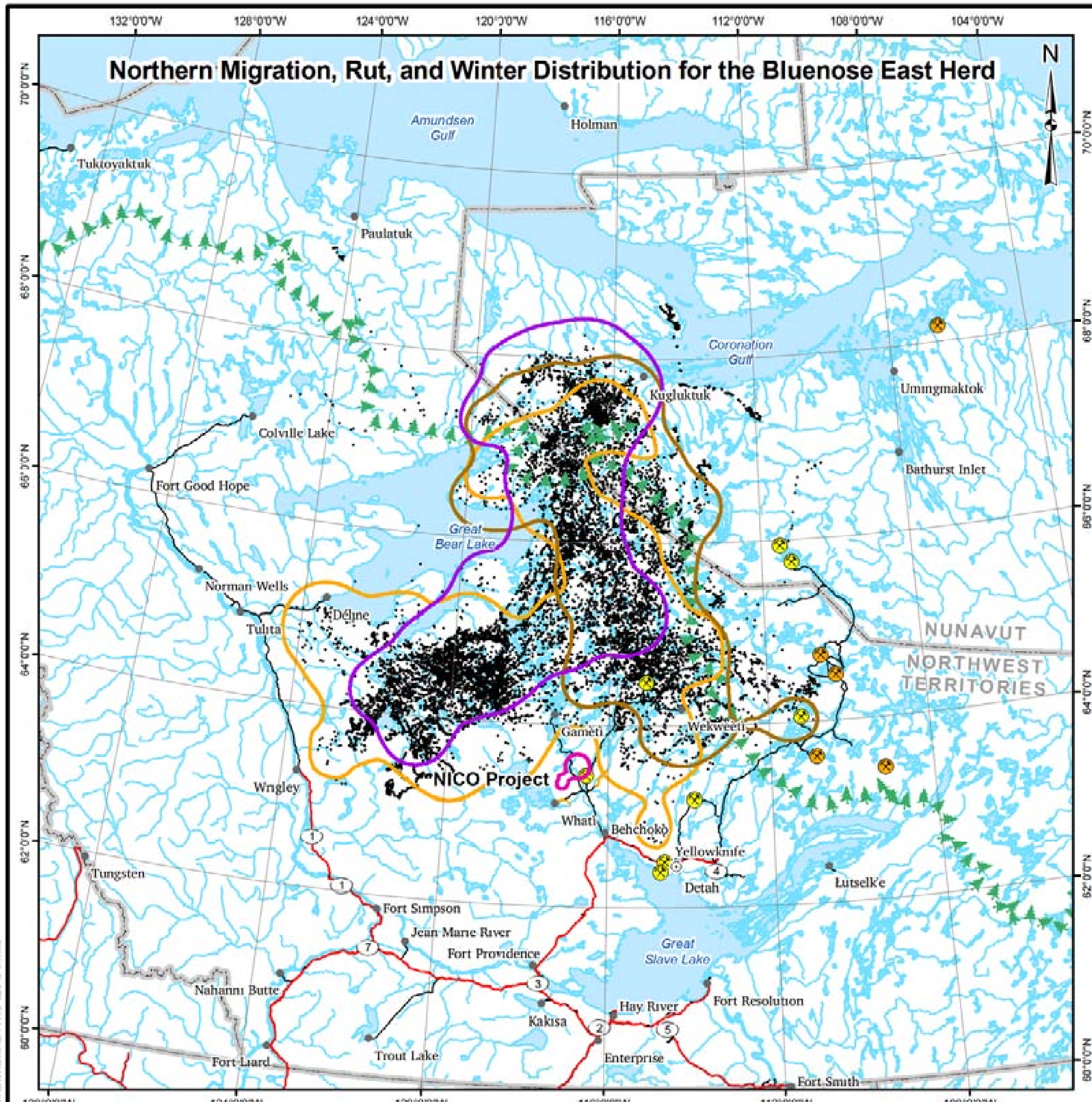
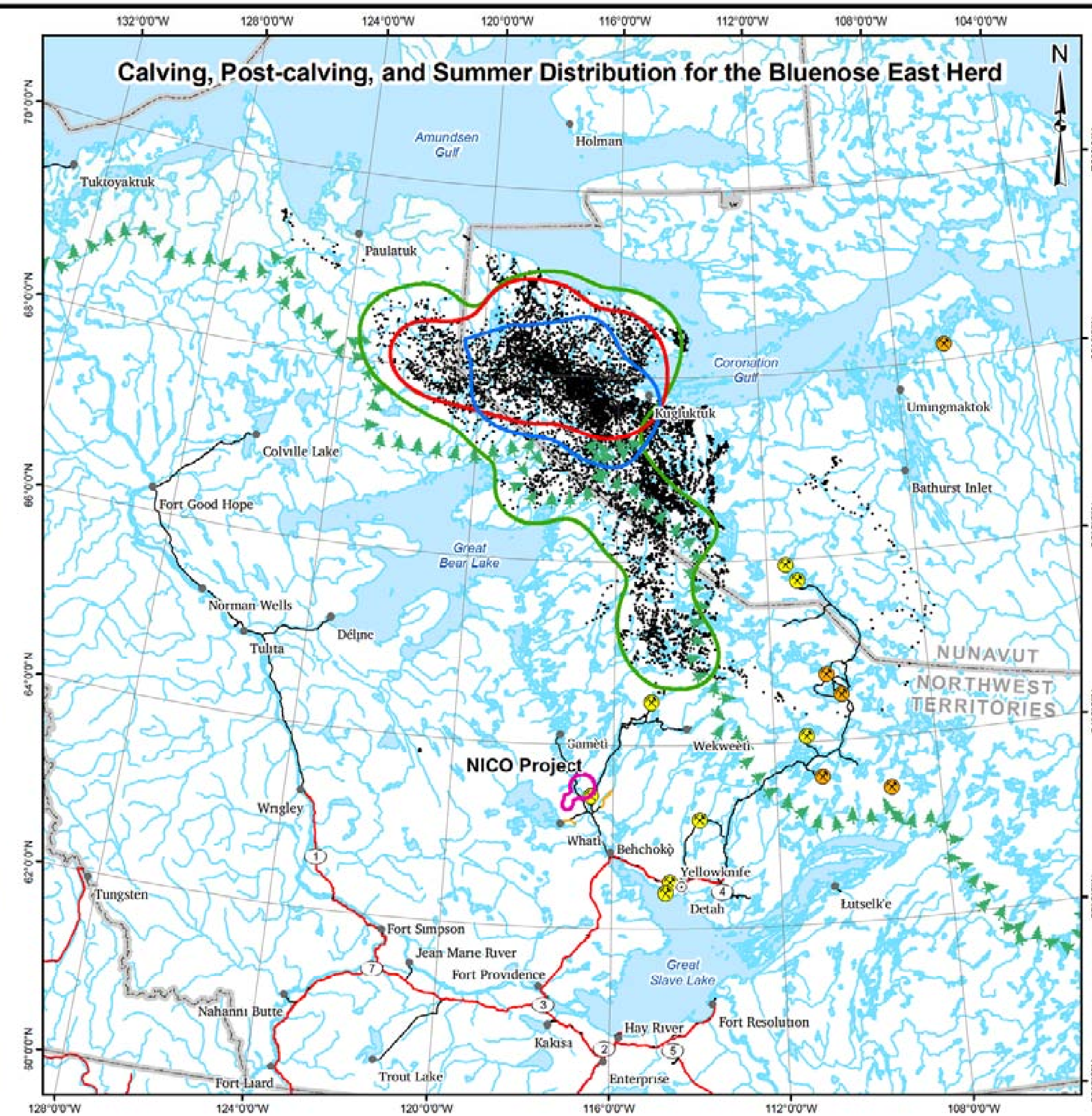
GIS	ANK	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.3-5





LEGEND

- PROPOSED OR OPERATIONAL MINE
- DECOMMISSIONED MINE
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- BLUENOSE EAST CARIBOU SATELLITE LOCATION
- TREELINE
- REGIONAL STUDY AREA
- NORTHERN MIGRATION
- RUT
- WINTER
- CALVING
- POST-CALVING
- SUMMER

150 0 150
SCALE 1:6,500,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Environment and Natural Resources, Government of Northwest Territories, 2010
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

ANNUAL AND SEASONAL DISTRIBUTION OF SATELLITE-COLLARED CARIBOU FOR THE BLUENOSE EAST HERD, 1996 TO 2010

FILE No. EA-Wild-025-GIS

PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
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GIS	ANK	03 Apr. 2011	**FIGURE: 8.3-6**	
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

Golder Associates
Edmonton, Alberta

Table 8.3-2: Number of Collared Caribou and Number of Satellite Point Locations within the Regional Study Area, 1995 to 2010

Herd	Season	Number of Collared Caribou in the RSA	Total Number of Collared Caribou	Number of Satellite Point Locations in the RSA	Total Number of Satellite Point Locations
Bathurst[a]	winter dispersal	6	94	21	13 734
	northern migration	0	85	0	1 484
	Calving	0	76	0	1 148
	post-calving	0	78	0	1 825
	summer dispersal	0	78	0	8 111
	fall (rut)	0	79	0	2 317
Bluenose East[b]	winter dispersal	0	43	0	11 166
	northern migration	0	36	0	3 256
	calving	0	43	0	2 253
	post-calving	0	43	0	2 394
	summer dispersal	0	39	0	6 441
	fall (rut)	0	35	0	4 770
Ahiak[c]	winter dispersal	0	62	0	20 119
	northern migration	0	59	0	3 917
	calving	0	57	0	1 884
	post-calving	0	57	0	2 033
	summer dispersal	0	57	0	6 447
	fall (rut)	0	55	0	5 327

[a] the Bathurst collared caribou estimates are based from 1995 to 2010.

[b] the Bluenose collared caribou estimates are based from 1996 to 2010.

[c] the Ahiak collared caribou estimates are based from 2001 to 2010. Ahiak data from 2008 to 2010 were combined with Ahiak and Beverly herd satellite collar data.

RSA = regional study area for the anticipated mine site and NPAR.

Table 8.3-3: Number of Collared Caribou and Number of Locations within 50 km of the NICO Project, 1995 to 2010

Year	Bathurst		Bluenose East		Ahiak	
	Number of Satellite-Collared Caribou	Number of Satellite Locations	Number of Satellite-Collared Caribou	Number of Satellite Locations	Number of Satellite-Collared Caribou	Number of Satellite Locations
1995	0	0	ND	ND	ND	ND
1996	4	5	0	0	ND	ND
1997	0	0	0	0	ND	ND
1998	5	8	0	0	ND	ND
1999	7	48	0	0	ND	ND
2000	5	40	0	0	ND	ND
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	1	7	0	0	0	0
2005	5	44	0	0	0	0
2006	3	5	0	0	0	0
2007	3	9	1	1	0	0
2008	0	0	0	0	0	0
2009	0	0	0	0	0	0
2010	0	0	0	0	0	0

ND = data is not available because there were no radio-collared caribou in these herds during the indicated years.

The area used by barren-ground caribou during the winter varies among years (Case et al. 1996; Gunn et al. 2002). The Bathurst caribou herd has the greatest probability of being affected by the NICO Project, as small numbers of individuals have been recorded in the proximity of the study areas during several years (Table 8.3-3). Bluenose East caribou are not likely to be influenced by the NICO Project in most years, as only 1 individual has been recorded within 50 km of the NICO Project from 1996 through 2008 (Table 8.3-3). Individuals from the Ahiak caribou herd have the lowest likelihood of being influenced by the NICO Project, as individuals from this herd have not been recorded within 50 km of the NICO Project (Table 8.3-3).

The RSA is within the range identified for NWT North Slave woodland caribou population (ENR 2009a); however, John Mantla (Behchokǫ̀, 2003, pers comm.) indicated that he knew of no traditional hunting of woodland caribou in the area, and believed that they were not commonly present in the study areas. Traditional knowledge indicates that woodland caribou tend to be more common to the west of the RSA, beyond the community of Whatì (Dogrib Treaty 11 Council 2001).

8.3.2.2.2 Abundance, Group Size, Composition, and Distribution

Mine Regional Study Area

Caribou data collected during field programs did not differentiate between barren-ground and woodland caribou as it is difficult to discriminate individuals of each group from aerial, pellet, and winter track surveys. Regardless, the surveys were scheduled around movements of barren-ground caribou. During aerial surveys in the mine RSA, 98 caribou groups consisting of 1014 individuals were recorded. Group size ranged from 1 to 50 individuals, although most of the groups tended to be small. For example, 40% of the groups contained 1 to 4 individuals, and 53% of the groups contained 5 to 29 individuals. Only 7 groups (7%) were comprised of 30 or more individuals.

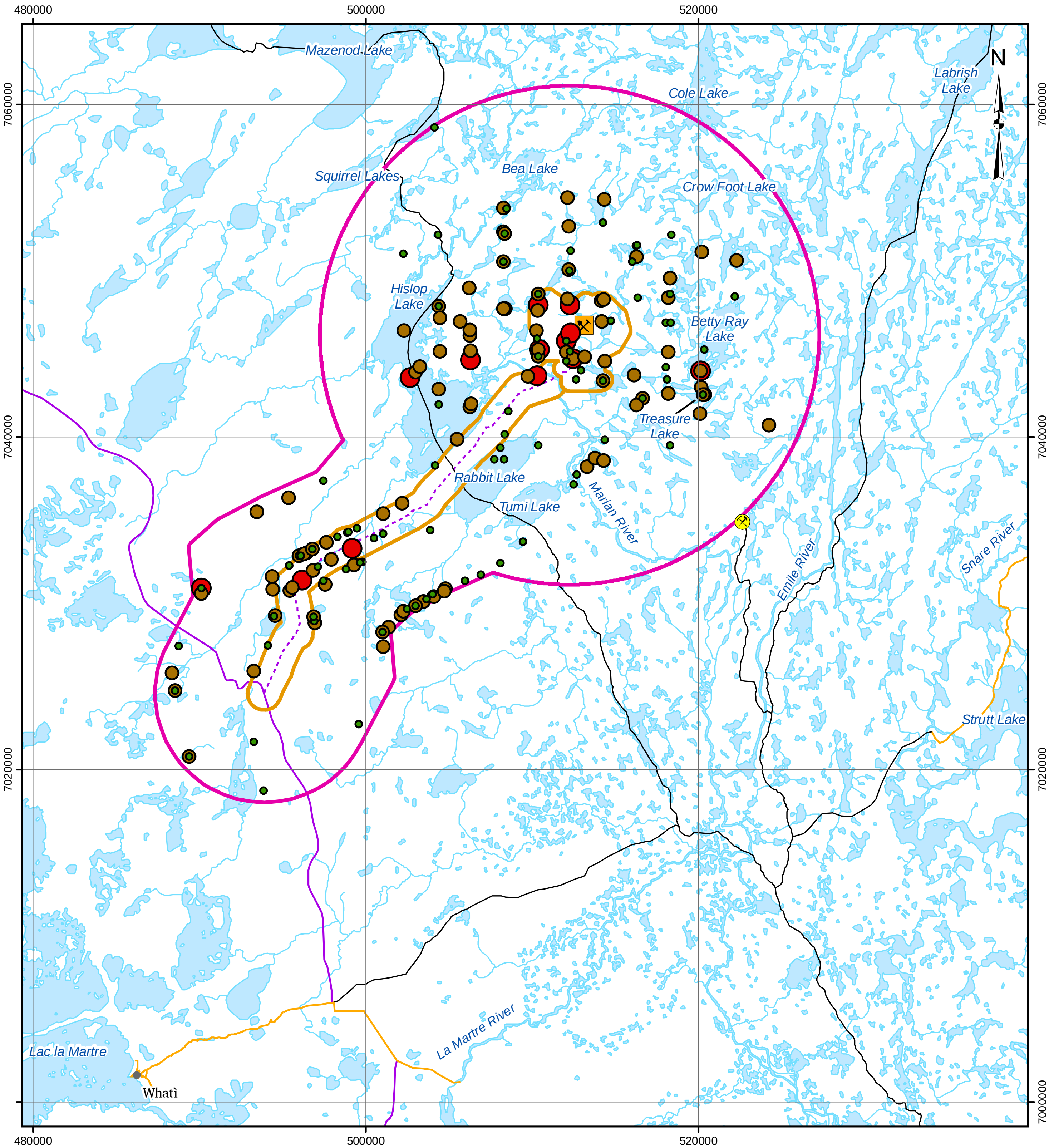
The observed number of caribou and caribou density in the mine RSA varied greatly among years (Table 8.3-4). Mean caribou density within the mine RSA from 2004 to 2006 was 14.8 ± 2.6 caribou/km^2, whereas density from 2007 to 2010 was 0.82 ± 0.21 caribou/km^2 (density was estimated by summing the total number of individuals observed per transect and dividing this sum by the total area surveyed per transect [Annex D, Section 5.3.3]). This is likely due to the small size of the study area relative to the winter home range of barren-ground caribou herds, as well as the potential for high daily movement rates (ranging from 2 km to over 20 km per day between November and May; Gunn et al. 2001) and their highly variable local scale movements and distributions during the winter (Curatolo 1975; Banfield and Jakimchuk 1980).

Caribou distribution was concentrated within a central band across the mine RSA; fewer caribou were observed in the northern and southern portions of the study area (Figure 8.3-7). These observations were associated with the hilly regions of the study area and the associated bedrock-open conifer habitat; however, snow tracks recorded during aerial surveys indicated that caribou used most of the study area (Figure 8.3-8).

Table 8.3-4: Observed and Estimated Number of Caribou in the Mine Regional Study Area, 2004 to 2010

Survey Date	Number of Caribou Observed	Estimated Number of Caribou[a]
26 November 2004	409	2 556
10 December 2004	8	50
11 April 2005	402	2 512
4 May 2005	32	200
11 April 2006	39	244
6 December 2006	0	0
11 April 2007	0	0
11 December 2007	91	455
15 April 2008	2	10
12 December 2008	0	0
17 December 2009	24	120
22 March 2010	7	35

[a] Calculated as the number of observed caribou divided by the proportion of the mine regional study area surveyed.



LEGEND

NICO PROJECT

RAYROCK MINE

POPULATED PLACE

EXISTING ALL-WEATHER ROAD

EXISTING WINTER ROAD

PROPOSED NICO PROJECT ACCESS ROAD

PROPOSED TŁĮCHǪ ROAD ROUTE

WATERCOURSE

WATERBODY

NUMBER OF CARIBOU

1 - 4

5 - 29

> 30

LOCAL STUDY AREA

REGIONAL STUDY AREA

10 0 10

SCALE 1:325,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and GeoGratis.

Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED

NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

CARIBOU DISTRIBUTION AND GROUP SIZE IN THE REGIONAL STUDY AREA, 2004 TO 2010

Golder Associates

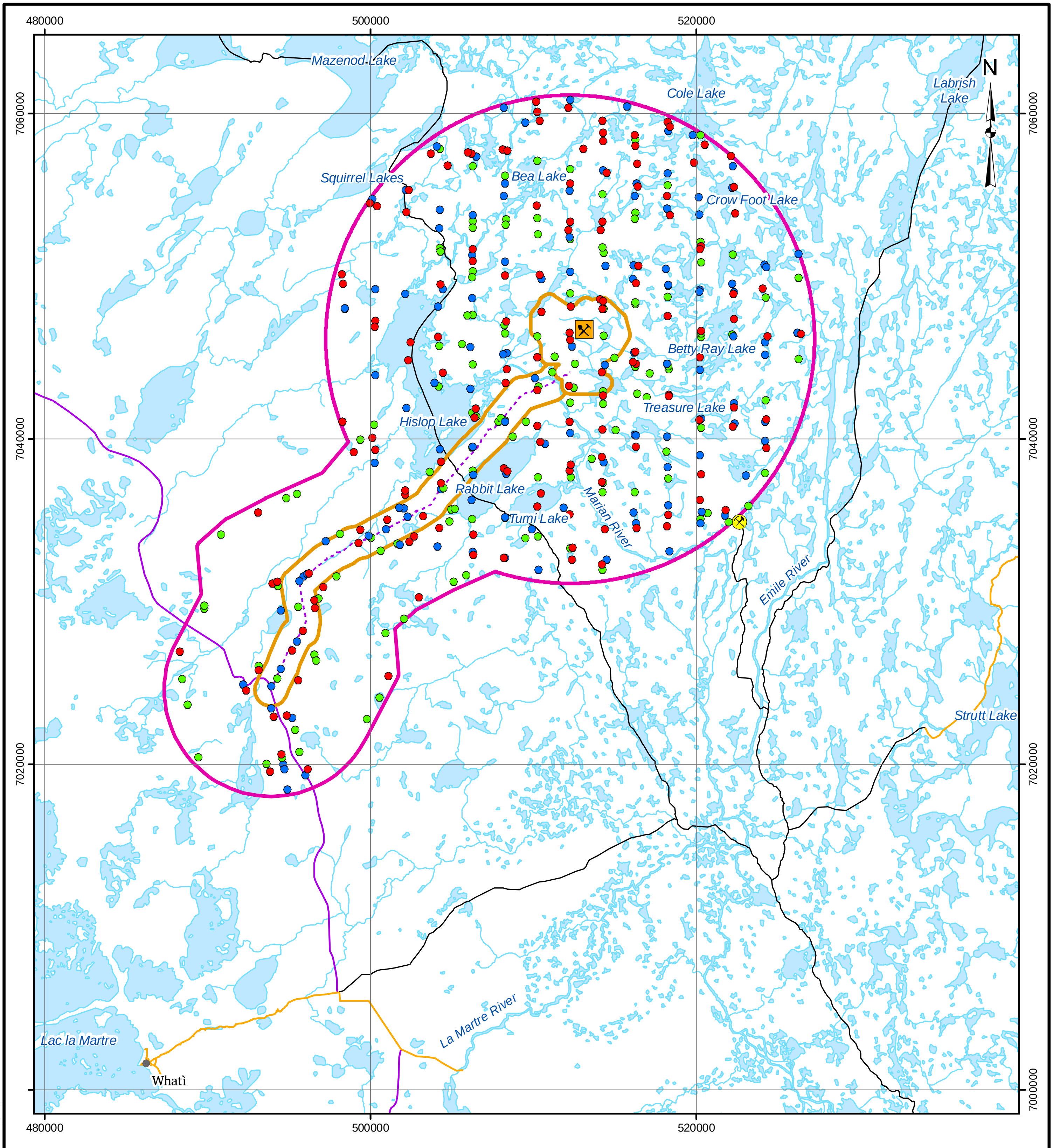
Edmonton, Alberta

FILE No. EA-Wild-026-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	LD	27 Oct. 2008	
GIS	ANK	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.3-7

G:\2008\1373\08-1373-0017 Fortune Minerals Nico EIS\GIS\Mapping\MXD\Wildlife\EA-Wild-026-GIS.mxd



LEGEND

- NICO PROJECT
- RAYROCK MINE
- POPULATED PLACE
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- WATERCOURSE
- WATERBODY

TRACK DENSITY

- HIGH (CONTINUOUS TRACKS OR NETWORK)
- MEDIUM (MULTIPLE SINGLE TRACKS/TRAILS)
- LOW (OCCASIONAL SINGLE TRACKS)
- LOCAL STUDY AREA
- REGIONAL STUDY AREA

10 0 10

SCALE 1:325,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

CARIBOU SNOW TRACK INDEX
FROM AERIAL SURVEYS, 2004 TO 2010

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-027-GIS

PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	LD	27 Oct. 2008	
GIS	MK	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.3-8

G:\2008\1373\08-1373-0017 Fortune Minerals Nico EIS\GIS\Mapping\MXD\Wildlife\EA-Wild-027-GIS.mxd

In addition to the aerial surveys, caribou activity in the region was estimated from the presence of satellite-collared animals. Using an area of 50 km around the NICO Project, there have been 167 satellite collar locations recorded from 34 caribou from 1996 to 2009. All but 1 of these locations were from individuals of the Bathurst caribou herd. Satellite-collared Bathurst caribou were present in 1996, 1998 to 2000, and 2004 to 2007. From 1 to 7 individuals were present in each of these years. All of these locations were recorded between November and April. These data suggest that the probability of Bathurst caribou occurring in the RSA during winter is highly variable among years (Table 8.3-3; Table 8.3-4). One location from a Bluenose East caribou individual was recorded on 28 November 2007 (Table 8.3-3).

Determining the group composition of caribou during the winter is difficult during an aerial survey. Calves have grown substantially and most bulls have lost their antlers, making it difficult for observers to determine age and sex of the animals. As a result, the composition of 64% of the 98 caribou groups observed was not determined. For the remaining 35 groups where group composition could be determined, 63% contained only adults and 37% were nursery groups (i.e., groups with calves).

Dominant group behaviour was recorded for 95 groups during the 9 aerial surveys with caribou observations. Behaviour was categorized as either feeding/resting (bedded, standing, feeding) or moving (walking, trotting, running). Groups displaying these 2 behaviours were approximately equal. For example, 44 groups exhibited feeding/resting behaviour and 51 groups were moving. With respect to habitat, from 2004 to 2006 most caribou groups were observed in frozen lake (66%) and coniferous spruce (20%) habitats. Similarly, from 2007 to 2010 most caribou group observations were made in frozen lake (53%) and coniferous spruce (29%) habitats.

Ground-based snow track surveys indicated that caribou track densities were high in coniferous spruce and bedrock-open conifer habitats within the mine RSA in 2005 (Table 8.3-5). Caribou tracks were also recorded in deciduous aspen-paper birch, open bog, treed bog, and frozen water habitats in 2005. Fifty-two percent of the observations were classified as networks (i.e., assumed to have 5 times the activity level of a single track). Trails (i.e., assumed to have 3 times the activity level of a single track) accounted for 38% of the observations, and single tracks accounted for 8% of the caribou track observations. No caribou tracks were recorded within the mine RSA in 2009. Due the limited availability of some habitats in the RSA (Annex D [Section 5.3.3]) survey effort (distance sampled) was low or did not occur in burn, coniferous pine, marsh/graminoid fen, shrubland, and treed fen habitats (Table 8.3-5).

Table 8.3-5: Snow Track Density and Habitat Selection of Caribou among Habitats within the Mine Regional Study Area, 2005

Habitat Type	Number of Tracks (mean ± 1SE)[a]	Observed Use (TKD)	Distance Sampled (km)	Proportion of Total Habitat Available[b]	Proportion of Total Tracks [Use]	95% Confidence Intervals for Use
Bedrock-Open Conifer	47.4 ± 15.3	102.0	1.88	0.11	0.23	0.17 - 0.29
Burn	NS	NS	0	<0.01	NS	NS
Coniferous Pine	0	0.0	0.05	0.01	0.00	0
Coniferous Spruce	25.8 ± 6.9	245.5	6.52	0.56	0.55	0.49 - 0.62
Deciduous Aspen-Paper Birch	46.4 ± 23.4	39.3	0.17	0.01	0.09	NA[d]
Marsh/Graminoid Fen	0	0	0.01	0.01	0.00	NA[d]

Table 8.3-5: Snow Track Density and Habitat Selection of Caribou among Habitats within the Mine Regional Study Area, 2005 (continued)

Habitat Type	Number of Tracks (mean ± 1SE)[a]	Observed Use (TKD)	Distance Sampled (km)	Proportion of Total Habitat Available[b]	Proportion of Total Tracks [Use]	95% Confidence Intervals for Use
Open Bog	45.8[c]	20.6	0.14	0.01	0.05	NA[e]
Shrubland	NS	NS	0	0.01	NS	NS
Treed Bog	29.3 ± 10.2	16.2	0.25	0.04	0.04	0.01 - 0.06
Treed Fen	NS	NS	0	0.01	NS	NS
Frozen Water (Ice)	24.1 ± 14.1	19.0	0.78	0.23	0.04	0.02 - 0.07
Total		**442.6**	**9.80**	**1.00**	**1.00**	

[a] number of tracks per km surveyed per days since last snow fall. Includes single tracks, trails, and networks weighted by 1, 3, and 5, respectively.

[b] proportion of Total Habitat Available = Expected Proportion of Use. A habitat type is preferred if the expected proportion of use is below the 95% confidence intervals for use of that habitat type, the habitat is neutrally selected if the expected proportion of use is within the 95% confidence intervals, and the habitat is avoided if the expected proportion of use is above the 95% confidence interval values.

[c] only the mean is reported because only 2 sites were surveyed in open bog habitat.

[d] expected frequency of use was less than 5.

[e] not reported because surveys were only completed in 2 segments of open bog habitat.

SE = Standard Error; TKD = Presence of tracks (i.e., 0 [if no tracks, trails, or networks were observed] or 1 [if at least one trail, track, or network was observed) per km surveyed per days since last snow fall; km = kilometre; NS = Not Surveyed; NA = Not Applicable.

Pellet surveys in early summer detected the highest densities of caribou pellets in bedrock-open conifer and mixedwood spruce-paper birch-aspen habitats (Table 8.3-6). A few pellets were found in deciduous trembling aspen-paper birch and treed bog habitats. No pellets were found in other habitat types.

Table 8.3-6: Caribou Pellet Group Density among Habitats within the Mine Regional Study Area, 2005 to 2007

Habitat Type	Number of Pellet Groups (mean ± 1SE)[a]	Distance Sampled (km)
Bedrock-Open Conifer	4.27 ± 3.39	1.76
Coniferous Pine	0	0.04
Coniferous Spruce	0	1.09
Deciduous Trembling Aspen-Paper Birch	1.0	0.26
Mixedwood Spruce-Paper birch-Aspen	6.19 ± 5.72	2.84
Open Bog	0	0.19
Treed Bog	0.50 ± 0.50	6.89
Total		**13.07**

[a] number of pellet groups per habitat type per transect.

SE = Standard Error; km = kilometre.

NICO Project Access Road Regional Study Area

During aerial surveys in the NPAR RSA, 126 caribou groups comprising 1168 animals were recorded. Group size ranged from 1 to 50 individuals, and most of the groups tended to be small, with an average group size of 9 animals. Groups containing 1 to 4 individuals comprised 46% of the observations, and group containing 5 to 29 individuals, comprised 48% of the observations. Only 8 groups (6%) were comprised of 30 or more individuals.

Similar to the mine RSA, the observed number of caribou in the NPAR RSA varied greatly among years (Table 8.3-7). Caribou distribution within the NPAR study area was concentrated south to south-east of Rabbit and Hislop lakes. A smaller concentration of caribou sightings occurred north of Whatì at the southwest extent of the road transects. Most observations of caribou groups were made in coniferous spruce (33%) or frozen lake (29%) habitat.

Table 8.3-7: Observed and Estimated Number of Caribou within the NICO Project Access Road Regional Study Area, 2004 to 2008

Survey Date	Number of Caribou Observed	Estimated Number of Caribou[a]
26 November 2004	554	6 156
10 December 2004	370	4 111
11 April 2005	194	2 156
04 May 2005	13	144
11 April 2006	0	0
6 December 2006	2	22
11 April 2007	4	44
11 December 2007	21	233
15 April 2008	0	0
12 December 2008	0	0
17 December 2009	0	0
22 March 2010	0	0

[a] calculated as the number of observed caribou divided by the proportion of the NPAR regional study area that was surveyed; the NPAR RSA was based on a 50-km road at the time of the surveys.

Of the 126 caribou groups observed, 92 were classified as nursery or non-nursery groups. Non-nursery and nursery groups made up 67% and 33% of the classified groups, respectively. Dominant group behaviour was recorded for 113 groups during the 7 aerial surveys with caribou observations. Of these, 74 (65%) were displaying feeding/resting behaviour and 39 (35%) were moving.

Caribou winter tracks were observed in coniferous pine and coniferous spruce habitats within the NPAR study area (Table 8.3-8). Due the limited availability of some habitats in the study area, survey effort was low in bedrock-open conifer, burn, frozen lake, open bog, and shrubland habitats (Annex D [Section 5.3.3]).

Single tracks comprised 23% of caribou track observations, and trails comprised 76% of caribou track observations within the NPAR. No caribou track networks were recorded within the NPAR study area.

Table 8.3-8: Caribou Snow Track Density among Habitats within the NICO Project Access Road Regional Study Area, 2005 and 2008

Habitat Type	Number of Tracks (mean ± 1SE)[a]	Observed Use (TKD)	Distance Sampled (km)
Bedrock-Open Conifer	0	0	0.23
Burn	0	0	0.08
Coniferous Pine	0.62 ± 0.62	2.78	2.60
Coniferous Spruce	0.17 ± 0.11	3.58	24.87
Deciduous Aspen-Paper Birch	0	0	0.61
Marsh/Graminoid Fen	0	0	1.49
Open Bog	0	0	0.20
Shrubland	0	0	0.04
Treed Bog	0	0	1.50
Treed Fen	0	0	2.64
Frozen Water (Ice)	0	0	0.20
Total		**6.35**	**34.45**

[a] number of tracks per km surveyed per days since last snow fall. Includes single tracks, trails, and networks weighted by 1, 3, and 5, respectively.

Note: the NPAR RSA was based on a 50 km road at the time of the surveys.

SE = Standard Error; TKD = Presence of tracks (i.e., 0 [if no tracks, trails, or networks were observed] or 1 [if at least one trail, track, or network was observed) per km surveyed per days since last snow fall; km = kilometre.

8.3.2.2.3 Habitat Selection and Foraging

Habitat preference from winter track surveys within the mine RSA in 2009 and within the NPAR study area could not be determined because the expected frequencies of caribou tracks among all habitats did not meet statistical assumptions. Analysis for the mine RSA in 2005 indicated that caribou track encounters were statistically different among 5 habitats (Chi-square = 122.2, df = 4, $P < 0.001$). Bonferroni confidence intervals suggested that treed bog and coniferous spruce habitats were selected in proportion to their availability (Table 8.3-5). Bedrock-open conifer habitat was preferred, while coniferous pine and frozen water habitats were avoided relative to availability.

Manly's standardized selection ratios (see Annex D, Section 5.3.3) using caribou aerial survey data suggested that frozen lake was the most preferred habitat within the mine RSA during winter from 2004 to 2010 (Table 8.3-9). Frozen lake was also the most preferred habitat within the NPAR according to aerial survey data from 2004 to 2010 (Table 8.3-9).

Table 8.3-9: Manly's Selection Ratios for Caribou Observations during Aerial Surveys within the Mine Regional Study Area, NICO Project Access Road Regional Study Area from 2004 to 2010

Habitat Type	Actual Proportion of Use	Expected Proportion of Use	Manly's Standardized Selection Ratio
Mine RSA 2004 to 2006			
Bedrock-open conifer	0.05	0.12	0.10
Coniferous spruce	0.21	0.60	0.08
Treed bog	0.03	0.04	0.15
Frozen lake	0.71	0.24	0.67
Mine RSA 2007 to 2008			
Bedrock-open conifer	0.20	0.13	0.30
Coniferous spruce	0.20	0.57	0.07
Treed bog	0	0.04	0
Frozen lake	0.60	0.19	0.63
Mine RSA 2009 to 2010			
Bedrock-open conifer	0	0.13	0
Burn	0	0.10	0
Coniferous spruce	0.57	0.53	0.34
Treed bog	0	0.04	0
Frozen lake	0.43	0.20	0.66
NPAR RSA 2004 to 2010			
Coniferous pine	0.05	0.09	0.04
Coniferous spruce	0.37	0.65	0.05
Marsh/graminoid fen	0.05	0.05	0.10
Treed bog	0.18	0.07	0.25
Treed fen	0.01	0.05	0.02
Frozen lake	0.34	0.05	0.54

Note: the NPAR RSA was based on a 50 km road at the time of the surveys.
RSA = regional study area

8.3.2.3 Traditional and Non-traditional Use

Aboriginal groups have had a historically important and respectful relationship with caribou, and continue to do so today. The Tłįchǫ (Dogrib) people state that respect is shown by only taking what is needed, using all parts of the harvested animals, and discarding any unused parts in respectful ways. Respect is also shown by having and sharing knowledge of the caribou. A lack of knowledge, and therefore respect, will result in the caribou migrating elsewhere and a population decline. Traditional knowledge is collected through harvesting activities, verified through discussions with other harvesters and elders, and shared through oral narratives (Dogrib Treaty 11 Council 2001).

Based on the reviewed traditional knowledge and traditional land use information, caribou was and continues to be the most important resource harvested by Aboriginal groups with traditional lands near the NICO Project. Residents of both Whatì and Gamètì identified areas within the RSA for hunting, including areas around Hislop

Lake, the area around Bea Lake and Crowfoot Lake (Section 5.3.2). Gamètì and Whatì interview participants also identified a caribou hunting area near the NPAR between Hislop Lake and Rabbit Lake. Case et al. (1996) estimated that between 14 500 and 18 500 Bathurst caribou were harvested annually from 1982 to 1995, but recent studies suggest that these were overestimates of the caribou harvest (Adamczewski et al. 2009).

Non-aboriginal harvest of barren-ground and woodland caribou is regulated by the department of Environment and Natural Resources of the Government of the Northwest Territories (ENR). Resident hunters are allowed to harvest up to 2 barren-ground caribou, males only, each year (ENR 2010b). The resident harvest occurs in 2 peaks: one in the fall when the caribou are near the treeline (15 August to 15 November), and another in winter when the herd is accessible by ice road for part of the section (15 November to 30 April). Non-resident hunters can harvest a maximum of 2 caribou per year (15 August to 30 November in the North Slave region), and must obtain the services of a licensed outfitter; however, because of concerns about caribou population declines in the NWT, ENR implemented interim emergency conservation actions on 1 January 2010 (ENR 2010c). These emergency actions prohibit non-Aboriginals (both residents and non-residents) from hunting individuals from the Bathurst herd on their wintering grounds in the North and South Slave regions. The Yellowknife Dene First Nation also cancelled its fall caribou hunt in 2009 because of concerns over the Bathurst herd decline (Miltenberger 2010).

Hunting regulations for woodland caribou allow residents to harvest one Boreal or Northern Mountain caribou per year and non-residents can only hunt woodland caribou in the Mackenzie Mountains (ENR 2010b). The resident hunting season for woodland caribou is from 15 July to 31 January, while the non-resident season is from 25 July to 31 October. As with barren-ground hunts, non-residents must obtain the services of a licensed outfitter.

The minimum annual harvest is 11 000 caribou with a minimum economic value of $17 million dollars (includes meat replacement and outfitting) (ENR 2006). A recent socio-economic study found that the annual net value of the Beverly and Qamanirjuaq caribou harvest is more than $20 million (Soublière 2007). The NWT share of the Beverly and Qamanirjuaq caribou harvest accounts for less than $1 million of the annual revenue from harvested caribou; however, the economic value of harvested caribou is more than just food replacement value. Wild meat can be nutritionally superior to store-bought meat, and hunting provides exercise and contributes to a healthy lifestyle, and has other cultural benefits (Soublière 2007).

Aboriginal peoples are dependent upon the land for their survival and prosperity. For generations, they have harvested resources for their own use, and continue to do so today. In the 21st century the economies of many communities is made up of a mixture of the wage economy, the traditional/resource harvesting economy, and government transfer payments. Typically in many of these smaller communities, traditional harvesting continues to play an important role in the economy as well as in the social and physical well-being of the community (Parlee 1998; Fast and Berkes 1999).

The health of caribou is of concern for Tłı̨chǫ community members because of the importance of traditional harvesting. Traditional knowledge interview participants in Whatì said that the caribou between Hislop Lake and Lac La Martre do not appear healthy. Gamètì Elders indicated that the wildlife near the NICO Project may be affected if the NICO Project is developed. The Elders further noted that caribou migration may also change because of NICO Project-related mining noise, and that other animals may be attracted to the NICO Project because of food smells. In previous studies, Elders have indicated that the movements of the caribou have been affected by mining activities such as loud noise and fumes, but that the caribou may be adapting to the pollution

(Dogrib Treaty 11 Council 2001). Whatì interview participants said that caribou migration routes have changed, elaborating that while there used to be a caribou trail between Kwejinne Lake and Russell Lake, the caribou now travel in many different directions and are spread out (Section 5.3.2.6).

The health and survival of many aspects of the Aboriginal cultural landscape components are dependent upon the continued pursuit of traditional activities across the land and within the communities. Through years of continual use of the land and its resources, and the accumulated wealth of traditional knowledge, a strong cultural link between the people and the land has been established. As a result, there is a high level of respect for the land and the multitude of resources that it supplies (Annex B).

Caribou hunts often occur at specific locations during certain times of the year, and the success of these events is dependent upon the strong social customs associated with them. Families, band members, and friends gather communally to participate in these activities (Annex B). Hunts rely on strong social customs and cooperation, and these gatherings foster social customs, strengthen family ties, traditional knowledge, and an awareness of the land and its health and condition. Often there is the sharing and retelling of stories, as well as games, ceremonies, and rituals that reaffirm the existence, history, and identity of the group.

8.4 Pathways Analysis

8.4.1 Methods

Pathway analysis identifies and assesses the linkages between NICO Project components or activities, and the correspondent potential residual effects to caribou. Potential pathways through which the NICO Project could affect caribou were identified from a number of sources including the following:

- a review of the development description and scoping of potential effects by the environmental and engineering teams for the NICO Project;
- scientific knowledge, and experience with other mines in the NWT;
- engagement with the public, Aboriginal people, communities, and government; and
- consideration of potential effects identified from the TOR for the NICO Project.

The first part of the analysis is to produce a list of all potential effects pathways for the NICO Project (Section 6.4). Each pathway is initially considered to have a linkage to potential effects on caribou. This step is followed by the development of environmental design features and mitigation that can be incorporated into the development description to remove a pathway or limit (mitigate) the effects to caribou. Environmental design features include NICO Project design elements, environmental best practices, management policies and procedures, and social programs. Environmental design features are developed through an iterative process between the NICO Project's engineering and environmental teams to avoid or mitigate effects.

Knowledge of the environmental design features and mitigation is then applied to each of the pathways to determine the expected amount of NICO Project-related changes to the environment and the associated residual effects (i.e., effects after mitigation) on caribou. Changes to the environment can alter measurement endpoints such as soil and water chemistry, and the amount and quality of habitat. For an effect to occur there has to be a source (NICO Project component or activity) that results in a measurable environmental change (pathway) and a correspondent effect on caribou.

Project activity → change in environment → effect on caribou

Pathway analysis is a screening step that is used to determine the existence and magnitude of linkages from the initial list of potential effects pathways for the NICO 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 caribou. Pathways are determined to be primary, secondary (minor), or as having no linkage using scientific and traditional knowledge, logic, and experience with similar developments and environmental design features. Each potential pathway is assessed and described as follows:

- no linkage – pathway is removed by environmental design features and mitigation so that the NICO Project results in no detectable environmental change and residual effects on caribou relative to baseline or guideline values;
- secondary – pathway could result in a minor environmental change, but would have a negligible residual effect on caribou relative to baseline or guideline values; or
- primary – pathway is likely to result in a measurable environmental change that could contribute to residual effects on caribou relative to baseline or guideline values.

Primary pathways require further effects analysis to determine the environmental significance from the NICO Project on caribou. Pathways with no linkage to caribou or that are considered minor (secondary) are not analyzed further or classified in the DAR because environmental design features and mitigation will remove the pathway (no linkage) or residual effects on caribou can be determined to be negligible through a simple qualitative evaluation of the pathway. Pathways determined to have no linkage to caribou or those that are considered secondary are not predicted to result in environmentally significant effects on caribou. All primary pathways are assessed in the DAR.

8.4.2 Results

Potential pathways through which the NICO Project could affect caribou are presented in Table 8.4-1. Environmental design features and mitigation incorporated into the design of the NICO Project to remove a pathway or limit the effects to caribou are listed, and pathways are determined to be primary, secondary, or as having no linkage. Evaluation of effects on caribou considers changes to hydrology, water quality, air quality, soil quality, and vegetation during the construction, operation, and closure of the NICO Project, as well as effects remaining after closure. Changes in habitat availability or vital rates, such as fecundity, may ultimately affect the persistence of caribou populations into the future, and the continued opportunity for traditional and non-traditional use of caribou. The following section discusses the potential pathways relevant to caribou.

Table 8.4-1: Potential Pathways for Effects to Caribou and Caribou Habitat

NICO Project Component/Activity	Effect Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Mine infrastructure footprint (e.g., Open Pit, site roads, Co-Disposal Facility, and Airstrip) NICO Project Access Road	Direct loss and fragmentation of caribou habitat	The current layout of the mine footprint will limit the area that is disturbed (updated from 30 January 2009). NICO Project Access Road will be as narrow as possible, while maintaining safe construction and operation practices.	Primary
	Loss or alteration of local flows, drainage patterns (distribution), and drainage areas from the NICO Project footprint can cause changes to soils, vegetation, and caribou habitat	Use of culverts and other design features that reduce changes to local flows and drainage patterns and drainage areas.	Secondary
Operation of Co-Disposal Facility	Vertical and lateral seepage from the Co-Disposal Facility may cause changes to groundwater and surface water quality, and soils, which may affect vegetation and caribou habitat	The Co-Disposal Facility will minimize seepage; runoff from the facility will be captured in Seepage Collection Ponds and diverted to the Mineral Process Plant for recycling, or the Effluent Treatment Facility. At closure and post-closure, runoff will flow to constructed wetlands for treatment or the Open Pit. Any potential acid-generating Mine Rock will be sequestered within the interior of the Co-Disposal Facility. Overburden directed to the Co-Disposal Facility will reduce any infiltration and will be used to cover any areas in the core of the pile where potential acid-generating Mine Rock is to be sequestered.	No Linkage
	Leeching of dissolved metals from mine rock may cause changes to groundwater and surface water quality and soils, which may affect vegetation and caribou habitat		
	Uptake of metals by caribou through ingestion of tailings and dust from tailings on surface water, soils, and vegetation can affect caribou health		
Process water and potable water supply	Process and potable water requirements for the NICO Project may decrease drainage flows and surface water levels, and affect vegetation, wetlands, and caribou habitat	Capture and reuse site water to reduce fresh water requirements. Water from tailings thickener and from the Open Pit will be recycled for Mineral Process Plant operations. Excess water from the Seepage Collection Ponds will be recycled and/or treated prior to entering the receiving environment.	Secondary

Table 8.4-1: Potential Pathways for Effects to Caribou and Caribou Habitat (continued)

NICO Project Component/Activity	Effect Pathways	Environmental Design Features and Mitigation	Pathway Assessment
General construction and operation of mine and supporting infrastructure	Air emissions and dust deposition can cause changes to chemical properties of surface water, soils, vegetation, wetlands, and caribou habitat	Watering of roads will suppress dust production. Enforcing speed limits will assist in reducing dust. Equipment and fleet equipped with industry-standard emission control systems. Enclosing conveyance systems and processing facilities. Processing equipment with high efficiency bag houses to reduce emissions of particulate matter Operating procedures will be developed that reduce dust generation and air emissions (e.g., regular maintenance of equipment to meet emission standards).	Secondary
	Surface water runoff from the core mine facilities area can affect surface water, soil, vegetation, and caribou habitat	The Water Management Plan will control surface water on-site. Runoff from the mine site will be captured and diverted to the Effluent Treatment Facility or the Mineral Process Plant. The site will have sufficient storage capacity in Surge Pond to store both operating flows and storm events. Sewage will be treated and the effluent will either be re-used during processing or discharged to Peanut Lake through the Effluent Treatment Facility.	No Linkage
	Sensory disturbance can change the amount of different quality habitats, and alter caribou movement and behaviour (distribution) Change in energetic costs from disturbance or displacement	NICO Project design will use conventional insulation, baffles and noise suppressors on equipment. Surface blasting will be temporarily suspended if caribou are observed within the danger zone identified by the blast supervisor. The crushing plant will be shut done at night.	Primary

Table 8.4-1: Potential Pathways for Effects to Caribou and Caribou Habitat (continued)

NICO Project Component/Activity	Effect Pathways	Environmental Design Features and Mitigation	Pathway Assessment
		Stationary equipment will be housed inside buildings. Regular maintenance of equipment to limit emissions. All employees will be provided with environmental awareness training.	
	Physical hazards on the mine site, and collisions with vehicles and aircraft cause injury or mortality to individual caribou, which can affect population size	Temporarily suspend surface blasting when caribou is spotted within the danger zone identified by the blast supervisor. Removal of physical hazards will be part of the decommission plan. Speed limits will be established. The presence of caribou will be monitored and communicated to site personnel. All employees will be provided with environmental awareness training.	Secondary
General construction and operation of mine and supporting infrastructure	Spills on the mine site or along the NICO Project Access Road can affect surface water quality, soils, vegetation, and caribou habitat	Hazardous materials and fuel will be stored according to regulatory requirements to protect the environment and workers (i.e., Hazardous Substances Management Plan). Smaller storage tanks (e.g., engine oil, hydraulic oil, and waste oil, and coolant) will be double walled, or located in lined and bermed containment areas. Reagents and fuel Enviro-Tanks will be located in larger, double-walled containers. Domestic and recyclable waste dangerous goods will be stored on-site in appropriate containers to prevent exposure until they are shipped off-site to an approved facility.	No Linkage
	Spills on the mine site or along the NICO Project Access Road can increase risk of mortality to individual animals, which can affect caribou population size		No Linkage

Table 8.4-1: Potential Pathways for Effects to Caribou and Caribou Habitat (continued)

NICO Project Component/Activity	Effect Pathways	Environmental Design Features and Mitigation	Pathway Assessment
		Individuals working on-site and handling hazardous materials will be trained in the Transportation of Dangerous Goods. Soils from petroleum spill areas will be deposited and spread in a lined landfarm cell for bioremediation. An Emergency Response and Spill Contingency Plan will be developed. Emergency spill kits will be available wherever toxic materials or fuel are stored and transferred. Construction and mining equipment, machinery, and vehicles will be regularly maintained.	
	Improved access for harvesting can affect caribou population size	Develop and enforce "no hunting, trapping, harvesting, or fishing policy". Prohibit the use of recreational all terrain vehicles at site.	Primary
	Attraction to the NICO Project may increase predator numbers and predation risk, which can affect caribou populations	Most of the construction of the NICO Project Access Road will be based out of the site reducing the number of camps along the route. Skirt all buildings and stairs to the ground to limit opportunities for use as shelter. Development and implementation of a Domestic and Industrial Waste Management Plan. Food wastes will be collected in suitable receptacles that limit attraction or impact to caribou. Food wastes will be incinerated regularly. The incinerator will be housed at the Waste Transfer Area.	Secondary

Table 8.4-1: Potential Pathways for Effects to Caribou and Caribou Habitat (continued)

NICO Project Component/Activity	Effect Pathways	Environmental Design Features and Mitigation	Pathway Assessment
		Recyclables and waste hazardous materials will be stored on-site in appropriate containers to prevent exposure until shipped off-site to an approved facility. A Wildlife Effects Monitoring Program will be developed and implemented. Littering and feeding of wildlife will be prohibited. Education and reinforcement of proper waste management practices to all workers and visitors to the site. Education on the risk associated with feeding wildlife and careless disposal of food garbage. Ongoing review of the efficiency of the waste management program and improvement through adaptive management.	
Post-closure	Water quality in the Flooded Open Pit and outflow may affect caribou health	Water will be treated prior to release from the Flooded Open Pit using a wetland treatment system prior to discharge into Peanut Lake. Co-Disposal Facility will be capped during closure to isolate tailings and Mine Rock and prevent leeching.	No Linkage
	Long-term seepage from the Co-Disposal Facility can change groundwater and surface water quality, which can affect soils, vegetation, and caribou habitat		No Linkage

8.4.2.1 Pathways with No Linkage

A pathway may have no linkage if the pathway is removed by environmental design features and mitigation so that the NICO Project results in no detectable (measurable) environmental change and residual effects to caribou. The pathways described in the following bullets have no linkage to caribou and will not be carried through the effects assessment.

Changes to Habitat Quality, Movement, and Behaviour

- **Vertical and lateral seepage from the Co-Disposal Facility may cause changes to groundwater and surface water quality and soils, which may affect local vegetation and caribou habitat.**
- **Leaching of dissolved metals from the Co-Disposal Facility may cause changes to groundwater and surface water quality and soils, which may affect vegetation and caribou habitat.**
- **Long-term seepage from the Co-Disposal Facility can change groundwater and surface water quality, which can affect soils, vegetation, and caribou habitat.**

During the life of the NICO Project, there is the potential for leachate (e.g., acidity and metals) from the tailings and mine rock Co-Disposal Facility (CDF) to seep through the co-disposed materials and report as seepage into the Seepage Collection Ponds. Additionally, there is potential for arsenic as well as other metals (i.e., aluminum, arsenic, cadmium, cobalt, lead, selenium, and uranium) to be present in the leachate. Such water-borne chemicals could adversely affect vegetation growth through surface water runoff and seepage. Environmental design features and mitigation have been incorporated into the NICO Project to reduce the potential for water to contact metal leaching Mine Rock, tailings, and potentially acid generating rock and, thus reducing potential effects to the environment from surface water runoff and seepage from the CDF (Table 8.4-1).

The CDF is designed to limit runoff and seepage from contacting tailings and metal leaching Mine Rock by placing this material in the interior of the CDF interlayered with tailings. The cover placed on the top of the CDF at closure, will limit infiltration into the interior of the CDF where potentially acid generating and metal leaching rock is located.

Runoff and seepage from the CDF will not be released directly to the environment during construction or operations. Runoff and seepage from the CDF will report to 1 of 5 Seepage Collection Ponds. During operations, water in the Seepage Collection Ponds will be pumped to the Surge Pond. Water from the Surge Pond will be pumped for use in the Mineral Process Plant or pumped to the Effluent Treatment Facility for treatment prior to release into Peanut Lake.

At closure, the surface of the CDF will be covered; thereafter, runoff from the CDF will not be in contact with the mine rock or tailings materials. Seepage out of the toe of the CDF will continue to be collected in the Seepage Collection Ponds. Water from Seepage Collection Ponds Nos. 1, 2, 3, and 5 and the Surge Pond will pass through constructed Wetland Treatment Systems prior to release into Nico Lake. The use of wetland treatment will be subject to demonstration of its technical feasibility by testing during the operating life of the mine. The Open Pit will slowly flood after closure. The water level is expected to reach Elev. 260 m roughly 120 years after closure, at which point it will overflow. At that time the pit lake overflow water will be directed through a ditch to Wetland Treatment System No. 4, which will discharge into Peanut Lake.

The Grid Ponds currently produces measureable natural arsenic loadings into Nico Lake. After construction, all releases from the NICO Project site into Nico or Peanut Lake will be subject to monitoring and treatment by active or passive means. Overall, release of runoff and long-term seepage from the CDF is not expected to result in a detectable change to caribou habitat outside of the NICO Project footprint area relative to baseline conditions. Therefore, these pathways were determined to have no linkage to the persistence of caribou populations.

- **Surface water runoff from the core mine facilities area can affect surface water quality, soil, vegetation, and caribou habitat.**

Surface water runoff from the Open Pit and the Mineral Processing Plant facilities area could potentially affect vegetation and caribou habitat. These facilities incorporate several environmental design features to prevent release of untreated site water into the receiving environment (Table 8.4-1).

During operations, water that collects in the Open Pit sump, which will include seepage into the Open Pit as well as runoff from rainfall and snow, will be pumped to the Surge Pond. Runoff from the Mineral Processing Plant will be collected in a site runoff collection pond and then transferred to the Surge Pond. Sewage will be treated in a Sewage Treatment Plant and treated liquid will also be discharged into the Surge Pond. Water collected in the Surge Pond will be reclaimed to the Mineral Processing Plant to the extent that it is needed; all excess water will be pumped to the Effluent Treatment Facility. Following treatment, the water will be discharged through a diffuser into Peanut Lake.

After closure, dewatering of the Open Pit will cease and the Open Pit will slowly fill with water. The water level is expected to reach Elev. 260 m roughly 120 years after closure, at which point it will overflow. At that time, the overflow water from the Open Pit will be treated by one of several potential methods described in Section 3.9.4.3. After treatment, the Open Pit water will discharge into Peanut Lake. At closure, the Mineral Processing Plant will be demolished and the area will be covered with till and re-vegetated. Runoff from part of the area will drain into the Surge Pond and then into Wetland Treatment System No. 4. Runoff from the remainder of the area will drain directly into Wetland treatment System No. 4, which will discharge into Nico Lake. Closure of the CDF will focus on reducing the risk of wind and water erosion of tailings. The exposed tailings will be covered with a 0.5 m thick layer of glacial till underlain by a 0.25 m layer of sand. Erosion control practices (e.g., erosion mats) will be used to limit erosion of topsoil stockpiles.

Implementation of these environmental design features is expected to result in no detectable changes to vegetation and caribou habitat from the NICO Project. Subsequently, this pathway was determined to have no linkage to effects on the persistence of caribou populations.

- **Spills on the mine site or along the NICO Project Access Road can affect surface water quality, soils, vegetation, and caribou habitat**

Chemical spills are usually localized, and are quickly reported and managed. Mitigation practices identified in the Emergency Response and Spill Contingency Plan (Appendix 3.VI) and environmental design features (Table 8.4-1) will be in place to limit the frequency and extent of chemical spills that result from NICO Project activities. Hazardous material and fuel will be stored according to regulatory requirement to protect the environment and workers (i.e., Hazardous Substances Management Plan; [Appendix 3.V]). Smaller storage tanks (e.g., engine oil, hydraulic oil, waste oil, and coolant) will be double walled, and located in lined and bermed containment areas. Individuals working on-site and handling hazardous materials will be trained in the Transportation of Dangerous Goods. Emergency spill kits will be available wherever toxic materials or fuel are stored and transferred.

The implementation of the Emergency Response and Spill Contingency Plan, and environmental design features are expected to result in no detectable change to water quality, soils, vegetation, and caribou habitat. Consequently, this pathway was determined to have no linkage to effects on the persistence of caribou populations, and continued opportunity for traditional and non-traditional use of caribou.

Changes to Survival and Reproduction

- **Spills on the mine site or along the NICO Project Access Road can increase risk of mortality to individual animals, which can affect caribou population size.**

Chemical spills have not been reported as the cause of wildlife mortality at the Ekati Diamond Mine, Diavik Diamond Mine, Jericho Diamond Project, or Snap Lake Mine (Tahera 2008; BHPB 2010; DDMI 2010; De Beers 2010). Chemical spills are usually localized, and are quickly reported and managed. Mitigation practices identified in the Emergency Response and Spill Contingency Plan (Appendix 3.VI), and environmental design features will be in place to limit the frequency and extent of chemical spills at the NICO Project, and along the NPAR (Table 8.4-1).

The implementation of the Emergency Response and Spill Contingency Plan, environmental design features, and monitoring programs is expected to result in no detectable change to health or mortality of caribou. Consequently, this pathway was determined to have no linkage to effects on the persistence of caribou populations, and continued opportunity for traditional and non-traditional use of caribou.

- **Uptake of metals by caribou through ingestion of tailings and dust from tailings on surface water, soils, and vegetation can affect caribou health.**
- **Water quality in the Flooded Open Pit and outflow may be poor, which may affect caribou health.**

Caribou within the RSA may be directly and indirectly exposed to airborne chemicals through fugitive dust and air emissions from the NICO Project. Direct exposure to chemicals includes inhalation of fugitive dust and air emissions, drinking of water, inadvertent ingestion of soil while foraging or grooming, and ingestion of vegetation. Airborne chemicals may deposit directly onto the surface of plants or may deposit onto soils and be subsequently taken up through plant roots (vascular plants) or tissues (lichen). Therefore, caribou may be indirectly exposed to chemicals from fugitive dust and air emissions by intentionally or inadvertently consuming vegetation that has accumulated chemicals through the soil or air.

Water quality in the Flooded Open Pit and the subsequent outflow may represent a risk to individuals that drink the water. In addition, there is a general concern that caribou may drink from the Seepage Collection Ponds or associated containment ditches, which may result in negative changes to caribou health. As such, environmental design features have been incorporated into the NICO Project to eliminate or reduce potential effects from surface water runoff and seepage (Table 8.4-1). Runoff and seepage from the CDF will not be directly released to the environment during construction and operations. Runoff from the CDF will be contained and report to one of the Seepage Collection Ponds. At closure, the CDF will be covered with a 0.5 m layer of glacial till underlain by a 0.25 m layer of sand. The facility will be graded to capture surface runoff and reduce infiltration. Progressive reclamation and closure of the CDF will involve contouring and re-grading and covering with vegetation.

A wildlife health risk assessment was completed to evaluate the potential adverse effect to individual animal health associated with exposure to chemicals from the NICO Project. Sources of chemicals considered in the assessment include fugitive dust, air emissions, treated effluent, and surface water runoff and seepage. The potential for effects to the health of wildlife evaluated for the NICO Project included changes in air, water, soil, and vegetation quality.

Based on the calculated exposure ratios it is anticipated that atmospheric depositions and surface water discharges from the NICO Project will result in negligible health risks to caribou. The exposure ratios were calculated using the maximum predicted concentrations of contaminants of possible concern, which were predicted during operations, closure, and post-closure phases of the NICO Project. Risk was considered to be negligible if calculated exposure ratios were less than target risk levels of 1, which is consistent with standard practice in risk assessment. The exposure ratios for caribou directly and indirectly exposed to chemicals were orders of magnitude less than 1. Because no unacceptable health risks to caribou are anticipated during these phases of the NICO Project, it is predicted that caribou health risks will also be negligible during the construction and operations phases of the NICO Project (i.e., containments of possible concern, are anticipated to be present at lower concentrations during construction and operation). Consequently, these pathways were determined to have no linkage to effects on the persistence of caribou populations, and continued opportunity for traditional and non-traditional use of caribou.

8.4.2.2 Secondary Pathways

In some cases, both a source and a pathway exist, but the NICO Project is anticipated to result in a minor environmental change, and would have a negligible residual effect on caribou relative to baseline or guideline values. The pathways described in the following bullets are expected to be secondary and will not be carried through the effects assessment.

Changes to Habitat Quality, Movement, and Behaviour

- **Loss or alteration of local flows, drainage patterns (distribution), and drainage areas from the NICO Project footprint can cause changes to soils, vegetation, and caribou habitat.**

Water diversions are not required for the development of the NICO Project infrastructure footprint, as the footprint is located near the top of a watershed; however, the CDF will eliminate the Grid Ponds, which are situated in a runoff catchment. The loss of the Grid Ponds is expected to result in represent minor fluctuations in water level relative to baseline values of Nico Lake (Section 11.3.2.2).

Because treated effluent will immediately mix with water from Peanut Lake, flows from Peanut Lake into Burke Lake will be increased during periods of effluent discharge. In general, the influence of discharge from the NICO Project to Peanut Lake is anticipated to result in lilttle to no effect on water levels in downstream waterbodies, including Ponds 11, 12, and 13 and Burke Lake relative to baseline conditions (Section 11.3.2.2). The water management system for the NICO Project has been optimized in terms of internal recycling within the Plant, thickening of the tailings, and high level of reclaim water from the CDF back to the Plant. The implementation of the mitigation practices and environmental design features is expected to result in a minor change (secondary pathway) to the hydrology in the LSA from the NICO Project relative to baseline conditions, which should have a negligible effect on Peanut Lake and downstream waterbodies such as Pond 11, 12, and 13, and Burke Lake.

The NPAR will cross 9 streams. To mitigate effects to local flows, drainage patterns, and drainage areas along the NPAR, a bridge will be built to cross the Marian River while all other streams, because they are ephemeral, will be culverted. The mine infrastructure and NPAR footprints are not predicted to change local flows, drainage patterns, and drainage areas outside the range of baseline values. Therefore, changes to vegetation and caribou habitat are expected to be minor and have a negligible residual effect on the persistence of caribou populations.

- **Process and potable water requirements for the NICO Project may decrease drainage flows and surface water levels, and affect vegetation, wetlands, and caribou habitat.**

The NICO Project will withdraw freshwater for dust suppression, potable water, and plant operations from Lou Lake. Department of Fishery and Oceans allowable lake under ice withdrawal volumes are 10% of the available water volume calculated using the appropriate maximum expected ice thickness (DFO 2010). The available water volume of Lou Lake is 9.42 million cubic metres (Mm^3) (Section 11.3.2.2). Thus the allowable volume that could be pumped from Lou Lake in winter is approximately 942 000 m^3. Throughout the life of the NICO Project it is anticipated that fresh water withdrawals during construction and operations will range from 112 000 m^3/year under average climatic conditions up to 146 000 m^3/year during a 1:25 year dry period (Section 11.3.2.2). This is below the allowable volume of water that could be taken from Lou Lake.

Environmental design features that will be implemented to reduce the amount of water required for plant operations and domestic uses include the capture and reuse of site water and excess water from the Seepage Collection Ponds in the Plant operations and the recycling of water from tailings thickener in grinding operations (Table 8.4-1). Water requirements for the NICO Project are not expected to decrease drainage flows and surface water levels below baseline conditions (Section 11.2), and should result in a minor change to wetlands and caribou habitat. Therefore, this pathway is expected to have negligible residual effects to the persistence of caribou populations.

- **Air emissions and dust deposition can cause changes to the chemical properties of surface water, soils, vegetation, wetlands, and caribou habitat.**

Accumulation of dust (i.e., total suspended particulate deposition) and concentrations of air emissions produced from the NICO Project may result in a local indirect change on the quality of habitat available within the LSA. Air quality modelling was completed to predict the spatial extent of dust deposition and air emissions from the NICO Project (Section 10.4). Sources of dust deposition and air emissions modelled in the application case (maximum effect case) include blasting activities, haul roads, the Plant, activities at the Open Pit and other ancillary facilities, and vehicle traffic along the NPAR and the Proposed Tłįchǫ Road Route. Environmental design features and mitigation have been incorporated into the NICO Project to reduce potential effects from dust deposition (Table 8.4-1). For example, the watering of roads, Airstrip, and laydown areas during the non-winter period will facilitate dust suppression. In addition, programs will be implemented to review power and heat use to reduce energy use. Although these environmental design features and mitigation should reduce dust deposition and air emissions, assumptions incorporated into the model are expected to contribute to conservative estimates of emission concentrations and deposition rates (Section 10.4).

Trucks travelling on the winter roads, NPAR, and the Proposed Tłįchǫ Road Route have the potential to transfer dust from vehicles and loads (e.g., dust deposited on wheels and undercarriage while at the NICO Project and in Yellowknife); however, the relative contribution of these loads to the overall dust accumulation in the area along the roads is considered to be negligible (Section 10.4). Similarly, dust generation from NICO Project vehicles along the NPAR and proposed Tłįchǫ Road Route would occur annually, but would likely be higher during the non-winter period and not continuous (i.e., would occur less frequently during wet and cool conditions). Dust deposition is expected to result in minor and localized changes to vegetation and caribou habitat along the right-of-ways for the NPAR and Proposed Tłįchǫ Road Route. For example, Walker and Everett (1987) and Everett (1980) reported that effects were confined to a 50 m buffer on either side of a road. Moreover, Meininger and Spatt (1988) found that most of effects occurred within 5 to 50 m of a road, with less obvious effects observed between 50 m and 500 m from a road. Dust deposition from vehicles along the NPAR and Tłįchǫ Road Route are predicted to result in negligible residual effects to the persistence of caribou populations.

Air emissions from vehicles along the NPAR and existing winter roads were included in the application case and assumed that winter roads were in operation for 63 days for construction, after which the NPAR and the proposed Tłįchǫ Road Route would be open all year round. In general, emissions from the roads are small, and if extended over the whole year, a negligible effect from annual depositions was predicted (Section 10.4). Annual emissions from vehicles on the roads are anticipated to result in no detectable changes to soils and vegetation (Section 13.3.2.2 and Section 14.3.2.2), and are expected to have no detectable effects on caribou habitat relative to baseline conditions.

The results of the air quality modelling predicted that the maximum annual dust deposition resulting from the NICO Project is 1083 grams per square metre per year (g/m^2/y) within the NICO Project Lease Boundary, and 151 g/m^2/y outside of the NICO Project Lease Boundary (Table 8.4-2). Further, modelling showed minimal dust deposition (i.e., <79 g/m^2/y) beyond approximately 280 m from the NICO Project Lease Boundary (i.e., there should be limited dust deposition outside of the LSA) (Figure 8.4-1). The only area that is predicted to receive dust beyond the NICO Project Lease Boundary is a small area of land located north-northwest of the NICO Project Lease Boundary (Figure 8.4-1). The major sources of dust will be associated with the Open Pit and haul roads. The strongest effects from dust are generally confined to the immediate area adjacent to the dust source, such as roads (Walker and Everett 1987).

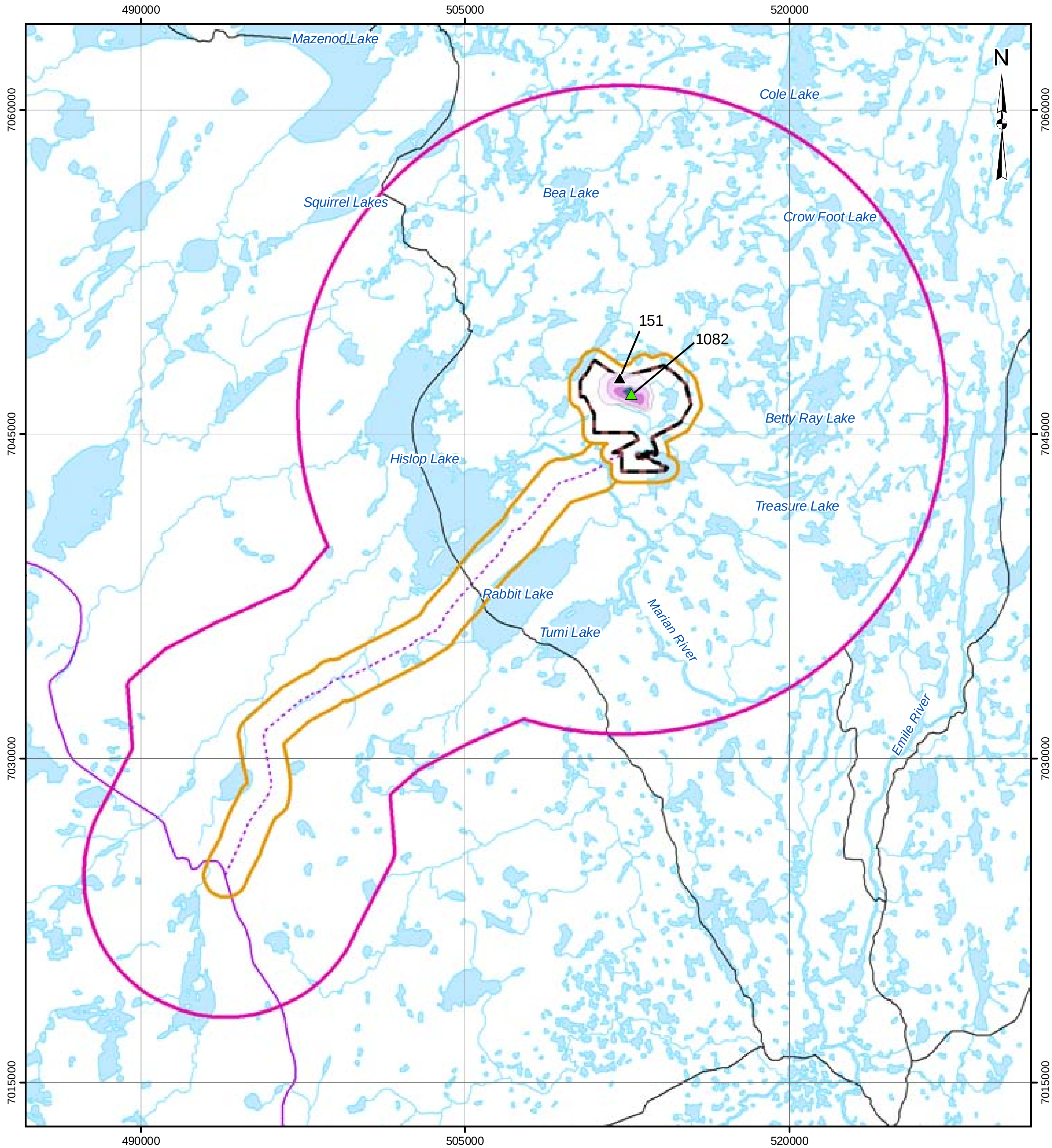
Table 8.4-2: Summary of Predicted Annual Deposition Rates from the NICO Project

Substance	Criteria	Maximum Predicted Deposition Rate			
		Local Study Area Baseline	Application		
			Outside NICO Project Lease Boundary	Distance to Maximum from NICO Project Centre (km)	Approximate Direction to Maximum
TSP	none	0.00 g/m^2/y	151 g/m^2/y	1.7	NW
PM_{10}	none	0.00 g/m^2/y	60 g/m^2/y	1.7	NW
$PM_{2.5}$	none	0.00 g/m^2/y	0.6 g/m^2/y	1.7	NW
PAI	0.25 keq/ha/y [a]	0.06 keq/ha/y	0.3 keq/ha/y	1.7	NW

[a] criteria is based on the Clean Air Strategic Alliance (CASA 1999).
NW = northwest; m = metre; g/m^2/y = grams per square metre per year; keq/ha/y = kiloequivalent per hectare per year; TSP = total suspended particulate; $PM_{2.5}$ = fine particles of 2.5 micrometres or less in size; PM_{10} = fine particles of 10 micrometres or less in size; PAI = potential acid input.

Potential acid input from air emissions can change the chemical properties of soil and water, which can affect vegetation and wildlife habitat (CASA 1999). For potential acid input and the application case, changes to soil and vegetation are expected to be minor (Section 13.3.2.2 and Section 14.3.2.2), which should result in minor changes to caribou habitat.

The air emission modelling results show that predicted peak concentrations for sulphur dioxide during operations are below the Ambient Air Quality Standards for NWT (Table 8.4-3); however, annual peak concentrations for nitrogen dioxide are predicted to slightly exceed guidelines outside of the NICO Project Lease Boundary, reaching levels of 68 micrograms per cubic metre (µg/m^3). The predicted distance to maximum nitrogen dioxide predictions is 1.7 km from the NICO Project centre. The spatial extent that is predicted to exceed the NWT standard is 4 ha in size and located north/northwest of the NICO Project Lease Boundary and within the LSA. Nitrogen dioxide concentrations exceed guidelines for a distance of about 250 m from the NICO Project Lease Boundary. For total suspended particulate, the maximum predicted dust concentration rate will occur within 1.7 km of the NICO Project centre (Table 8.4-3). Total suspended particulate air concentrations are predicted to exceed guidelines within 500 m from the NICO Project Lease Boundary (Figure 8.4-1). In other words, total suspended particulate concentrations outside of the LSA will be below recommended guidelines.



LEGEND

- PROJECT LEASE BOUNDARY
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁICHO ROAD ROUTE
- WATERCOURSE
- WATERBODY
- LOCAL STUDY AREA
- REGIONAL STUDY AREA
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA EXCLUDING PROJECT LEASE BOUNDARY
- MAXIMUM PREDICTION WITHIN LOCAL STUDY AREA

DEPOSITION ($g/m^2/yr$)

- >= 631
- 316 to < 631
- 158 to < 316
- 79 to < 158
- 0 to < 79

5 0 5

SCALE 1:250,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and GeoGratis.
Projection: UTM Zone 11 Datum: NAD 83

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

DISTRIBUTION OF ANNUAL TOTAL SUSPENDED PARTICULATE DEPOSITION RATE DURING NICO PROJECT OPERATIONS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-053-GIS				
PROJECT No. 09-1373-1004			SCALE AS SHOWN	REV. 0
DESIGN	JV	15 Feb. 2011	FIGURE: **8.4**-1	
GIS	MK	23 Feb. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

G:\2008\1373\08-1373-0017 Fortune Minerals Nico EIS\GIS\Mapping\MXD\Wildlife\EA-Wild-053-GIS.mxd

Table 8.4-3: Summary of Predicted Peak Annual Air Quality Concentrations from the NICO Project

Substance	Criteria ($\mu g/m^3$)[a]	Maximum Predicted Concentration			
		Baseline	Application		
		Concentrations in the Regional Study Area ($\mu g/m^3$)	Concentrations Outside NICO Project Lease Boundary ($\mu g/m^3$)	Distance to Peak Predictions from NICO Project Centre (km)	Approximate Direction to Maximum
Nitrogen dioxide	60	2	68.4	1.7	NW
Sulphur dioxide	30	0.5	1.0	1.7	NW
Total suspended particulate	60	2	166.0	1.7	NW

[a] standard based on Ambient Air Quality Standards for NWT.

$\mu g/m^3$ = micrograms per cubic metre; km = kilometre; NW = northwest.

Although concentrations are predicted to be above baseline conditions, the anticipated changes to habitat quality are considered minor and localized. Maximum reported values are, in part, a consequence of local topography as there is a small area northwest of the NICO Project where there are moderate changes in elevation (e.g., hill or cliff). The maximum predicted annual deposition rate of potential acid input and maximum concentration of nitrogen dioxide are both expected to occur within 1.7 km of the NICO Project centre and have values exceeding guidelines for only a short distance outside the north-northwest boundary of the NICO Project Lease Boundary (i.e., all values are below recommended guidelines outside of the LSA). When comparing changes to the elemental concentrations in soil from total suspended particulate deposition, predictions are below Canadian Council of Ministers of the Environment (2007) soil quality guidelines. Therefore, changes to the chemical content of soil should not affect the soils ability to support vegetation (habitat quality). In addition, the deposition predictions are considered to be conservative, and therefore the presented deposition rates are likely overestimated. Overall, changes in habitat quality (and associated changes to caribou movement and behaviour) due to dust deposition and air emissions are anticipated to be minor relative to baseline conditions (secondary pathway; Table 8.4-1). Consequently, residual effects to the persistence of caribou populations and the continued opportunity for traditional and non-traditional use of caribou from dust deposition and air emissions are predicted to be negligible.

Changes to Survival and Reproduction

- **Physical hazards on the mine site, and collision with NICO Project vehicles, aircraft, and vehicles on the Proposed Tłįchǫ Road Route causes injury or mortality to individual animals, which can affect caribou population sizes.**

Infrastructure (e.g., buildings, ditches, road berms, Airstrip berms, and Open Pit) and blasting activities associated with the NICO Project may be hazardous to caribou. Individuals may injure themselves when crossing road berms, Airstrip berms, and ditches. Caribou are also vulnerable to injury or mortality if they enter the Open Pit or CDF. It is expected that traffic and the presence of humans will deter caribou from entering the Open Pit and CDF. Also, a berm will be constructed around the Open Pit to discourage wildlife species from entering the Open Pit (Section 9). If the Open Pit is accessed inadvertently, caribou will be able to exit the Open Pit using the haul road. No caribou mortalities from animals entering the open pits at other mines in the NWT have been reported (BHPB 2010; DDMI 2010; De Beers 2010).

Construction and operation of the NICO Project and the Proposed Tłįchǫ Road Route will cause an increase in the volume of vehicle traffic in the RSA. Caribou may use roads more often during the winter because of the ease of travel along cleared roadways (Rost and Bailey 1979). Thus, the potential for collisions between vehicles and caribou may increase (Romin and Bissonette 1996; Hussain et al. 2007). Traffic speed and volume are the primary factors that contribute to road-related wildlife mortality. A total of 221 collisions involving animals have been reported in the NWT from 1998 to 2008 (DOT 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, internet sites). Most of these collisions occurred on highways (91%), with a few collisions reported in communities (7%), and rural areas (2%). Data in the DOT reports from 2006 to 2008 suggests that most of these collisions involve bison. Bison collisions accounted for an average of 72% of all animal collisions reported in the NWT (71% in 2006, 74% in 2007, and 70% in 2008). Recent records show very few collisions with caribou. One collision occurred in 1999 when 5 caribou were killed by a grocery (meat) truck on a portage on a winter road near Gordon Lake (EBA 2001). No caribou have been killed by vehicle collisions at operating mine sites in the NWT (BHPB 2010; DDMI 2010; De Beers 2010). The incremental increase in the number of caribou-vehicle collisions associated with the NICO Project and Proposed Tłįchǫ Road Route is expected to be minor relative to baseline conditions.

To mitigate the increase in mortality risk along roads in the NICO Project site, along the NPAR, and the Proposed Tłįchǫ Road Route several mitigation practices and policies will be implemented. A bus system will be available to transport workers from surrounding communities to site during construction and operation, which will reduce traffic volume (Table 8.4-1). Speed limits will be posted and enforced on the NPAR. The maximum speed on the NPAR will be 60 km/h and the speed limit will be 60 km/h within the NICO Project site. Lower speeds allow the motorist and animal to avoid a collision (van Langevelde et al. 2009). In addition, the presence of caribou and other wildlife will be monitored and communicated to site personnel.

Aircrafts are anticipated to be used for medical emergencies and the transport of some goods to site, during operations. A maximum of 4 round-trip flights per week are expected during NICO Project construction (Appendix 8.III). . Therefore the volume of air traffic associated with the NICO Project is predicted to be low but collisions with caribou have the potential to occur. The Wildlife Effects Monitoring Program (Appendix 18.II) identifies a course of action for removing caribou from roads and the Airstrip when necessary. No aircraft collisions with caribou at other mine sites in the NWT have been reported (BHPB 2010; DDMI 2010; De Beers 2010).

The implementation of environmental design features and mitigation (Table 8.4-1) are expected to decrease the risk to animals from physical hazards on-site and collisions with vehicles. Some environmental design features and mitigation that will be implemented at the NICO Project to reduce the risk of caribou injury or mortality from physical hazards and vehicle collisions include the following:

- blasting will be temporarily suspended when caribou are spotted within the danger zone identified by the blast supervisor;
- the CDF will be regularly monitored for caribou activity and hazards;
- road berms will be covered with small-sized granular material to reduce injury hazards to caribou crossing the roads;
- at decommissioning, the entire site area will be re-contoured to reduce hazards to caribou;

- ditches will be contoured or backfilled at decommissioning as appropriate to remove any hazards to caribou;
- speed limits will be established;
- the presence of wildlife will be monitored and communicated to site personnel;
- all employees will be provided with environmental awareness training; and
- caribou deterrent actions will be implemented by knowledgeable and trained personnel.

In summary, the implementation of environmental design features and wildlife management practices are expected to result in minor changes in mortality rate from physical hazards, and caribou-vehicle and caribou-aircraft collisions relative to baseline conditions, and should have a negligible effect on the persistence of caribou populations.

- **Attraction to the NICO Project may increase predator numbers and predation risk, which can affect caribou populations.**

Carnivores have a keen sense of smell and can be attracted from long distances if food items are frequently present (Eberhardt et al. 1982; Benn and Herrero 2002; Beckman and Berger 2003; Peirce and Van Daele 2006). Mining projects in the Arctic have reported carnivore attraction to landfills (BHBP 2007; DDMI 2008). Carnivores are also attracted to aromatic waste material such as petroleum-based chemicals, grey water, and sewage (CWS 2007). In addition, infrastructure may also attract carnivores as it can serve as a temporary refuge to escape extreme heat or cold. The attraction of carnivores can increase predation pressure on prey species (e.g., caribou) (CWS 2007; Liebezeit et al. 2009). This increase in predation may have the potential to cause local and regional population declines of caribou (Monda et al. 1994; CWS 2007; Liebezeit et al. 2009).

Improved waste management practices and staff education have resulted in decreasing the frequency of attractants at mine sites. Since 2004, no carnivores have been accidentally or intentionally destroyed at the Diavik mine (Section 15.2.3.9). No carnivores have been intentionally destroyed and only 1 individual has been accidentally killed at the Snap Lake Mine during the 11 years of exploration through current operation (Section 15.2.3.9).

A number of environmental design features and management plans will be implemented at the NICO Project to limit the attraction of wildlife (Table 8.4-1). These mitigation strategies are provided in the Wildlife Effects Monitoring Program (Appendix 18.II) and the Waste Management Plan (Appendix 3.IV), and are similar to management practices and policies implemented at other mines in the NWT and Nunavut. Some environmental design features and mitigation that will be implemented at the NICO Project include the following:

- food wastes will be collected in suitable receptacles that limit attraction or impact to wildlife;
- littering and feeding of wildlife will be prohibited;
- recyclables and waste hazardous materials will be stored on-site in appropriate containers to prevent exposure until shipped off-site to an approved facility; and
- education and reinforcement of proper waste management practices to all workers and visitors to the site.

Environmental design features and management plans should limit attractants at the NICO Project and result in a minor increase in local predator numbers and predation risk to caribou relative to baseline conditions (Table 8.4-1). Therefore, this pathway is predicted to have a negligible residual effect on the persistence of caribou populations.

8.4.2.3 Primary Pathways

The following primary pathways are analyzed and classified in the effects assessment for caribou.

- **Direct loss and fragmentation of habitat from the physical footprint of the NICO Project may alter wildlife movement (i.e., distributions) and behaviour, and affect the carrying capacity of the landscape to support populations.**
- **Sensory disturbance (e.g., presence of buildings, people, lights, smells, and noise) from the NICO Project changes the amount of different quality habitats, and alters movement and behaviour, which can influence survival and reproduction.**
- **Change in energetic costs from disturbance and displacement, which can influence survival and reproduction.**
- **Improved access for harvesting can affect caribou population size.**

8.5 Effects to the Abundance and Distribution of Caribou

8.5.1 General Approach

It is anticipated that the NICO Project (including the NPAR) will influence the Bathurst herd based on movements of collared animals and distributions determined from aerial surveys of the region. Alternately, the NICO Project should have no measurable effect on the Ahiak, Bluenose East, and North Slave (woodland) herds (Section 8.3.2.2.1). The NICO Project will likely alter the behaviour and movement of a few individuals from these herds that periodically travel through the RSA; however, the frequency and number of animals affected is not expected to result in a measurable change in the population size and distribution of the herds relative to current (baseline) conditions. Subsequently, the pathway for effects from the NICO Project on the Ahiak, Bluenose East, and woodland herds was determined to have no linkage. Thus, the emphasis in the effects analysis is on the Bathurst population.

The effects analysis considers all primary pathways that result in expected changes to the population size and distribution of caribou from the NICO Project, after implementing environmental design features and mitigation. Thus, the analysis is based on the residual effects from the NICO Project. Residual effects to caribou are analyzed using measurement endpoints (e.g., habitat quantity and quality, survival, and reproduction) and are expressed as effects statements.

The magnitude, spatial extent, and duration of changes in measurement endpoints (e.g., habitat quantity and quality) from the NICO Project and other developments are expected to be similar to or greater than the actual effects to the abundance and distribution of populations. Effects statements may have more than one primary pathway that link a NICO Project activity with a change in caribou population size and distribution. For example, the pathways for effects from changes in habitat quality, movement, and behaviour include influences from noise, dust deposition, and the presence of vehicles, and NICO Project infrastructure. The combination of direct (physical footprint) and indirect (noise, dust, and other sensory disturbances) effects can create a ZOI around the NICO Project that can change the behaviour and occurrence of caribou (Section 8.3.2.1.1).

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. All of these changes can ultimately affect caribou population size and distribution.

The spatial scale of the analysis considers the natural and human-related effects that occur across the landscape. For Bathurst caribou, individuals in the population are predicted to experience the effects from the NICO Project and other developments while moving around their winter range. Examination of the collar data indicate that 89% of previously collected locations of caribou were below the treeline during the winter period (Appendix 8.II). In addition, the influence of human disturbance on caribou distribution suggests that the response of individuals to development is likely different in the forest than on the tundra, which may be related to the function and structure of available habitat types (Section 8.3.2.1.1). Therefore, the caribou study area (or effects study area [Section 6.5.2]) was extended outside of the RSA, and was defined as the winter range of the Bathurst caribou herd below the treeline (Figure 8.1-2).

The temporal scale examines the natural and development-related changes from reference conditions through application of the NICO Project and reasonably foreseeable developments. Baseline conditions represent a range of temporal values on the landscape from reference (little to no development) to existing (2010) conditions. Environmental conditions on the landscape before industrial development (i.e., reference conditions) are considered part of the baseline (Section 6.5.2). 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 both the incremental and cumulative changes from the NICO Project on the landscape, caribou, and the use of caribou by people. Incremental effects represent the NICO Project-specific changes relative to baseline values in 2010 (current or existing conditions). NICO Project-specific effects typically occur at the local scale (e.g., habitat loss due to the Project footprint) and regional scale (e.g., combined habitat loss, dust, noise, and sensory disturbance from NICO Project activities [i.e., ZOI]).

Cumulative effects are the sum of all changes from reference values through application of the NICO Project (and future developments). In contrast to incremental effects from the NICO Project, cumulative effects occur across the winter range of the population (i.e., beyond local and regional scales). This is because caribou travel large distances during their seasonal movements and can be affected by the NICO Project and several other developments (Section 6.3). In other words, the combined local and regional effects from the NICO Project and other developments overlap with the distribution of the population.

Cumulative effects do not just include the combined effects from human development on caribou populations. Cumulative effects 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 phenomenon such as extreme insect harassment years, and periodic harsh and mild winters. The objective of the cumulative effects analysis is to estimate the contribution of human-related influences on the abundance and distribution of caribou, in context of natural changes in the ecosystem.

Detailed descriptions of the spatial and temporal boundaries, and methods used to analyze residual effects from the NICO 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. Due to the amount and type of data available, some analyses were qualitative and included professional judgement or experienced opinion.

8.5.2 Habitat Quantity and Fragmentation

8.5.2.1 Methods

Direct effects from the footprint of the NICO Project (including the NPAR) and other previous, existing, and future developments were analyzed through changes in the area and spatial configuration of habitat types on the landscape (i.e., landscape metrics). The incremental and cumulative changes in landscape metrics were determined for the winter range of the Bathurst caribou herd below the treeline (i.e., caribou study area). Landscape metrics for each habitat included total area, number of patches, and mean distance to the nearest similar patch. Decreases in habitat area and number of similar quality habitat patches can directly influence population size by reducing the carrying capacity of the caribou winter 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.

The quantity of caribou habitat was classified using the remote sensing Land Cover of Canada (1985 to 2000) provided by the Government of Canada in a Geographical Information System (GIS) platform. The land cover dataset was modified from 1000 m cell sizes to a 25 m resolution, and then joined with esker habitat in 1:50 000 scale national topographic database layers. The merged database was similar to the Slave Geological Province dataset used in Johnson et al. (2004, 2005); however, upon joining layers, the dataset was resampled to 200 m cell sizes using a nearest neighbour algorithm (versus 100 m in Johnson et al. [2004, 2005]) to reduce processing time. Tests for accuracy suggested that there were marginal differences in the overall areas per cover type between a 100 m resampled dataset, versus a 200 m resampled dataset (i.e., less than 0.1%). Finally, the Land Cover of Canada dataset was reclassified into 12 classes similar to Johnson et al. (2004, 2005). Visual inspections of the distribution of cover data in the areas that overlapped the Slave Geological Province and Land Cover of Canada guided the reclassification process.

Landscape metrics were determined using the program FRAGSTATS (Version 3.0; McGarigal et al. 2002, internet site) within a GIS platform. The analysis determined the extent of landscape fragmentation by calculating statistical outputs based on the values of each raster cell. Raster cells for habitats with extensive coverage (including disturbed areas) were increased to 200 by 200 m in size. For example, road widths are typically about 20 m; however, to include roads in the 200 m ecological land cover layer, roads must have a width of 200 m (including existing winter and all-weather roads, NPAR, and Proposed Tłįchǫ Road Route). Therefore, results determined from the fragmentation analysis are conservative and result in an overestimation of disturbance to the study area.

The number and type of previous, existing, and reasonably foreseeable developments in the Bathurst caribou study area are listed in Table 8.5-1 and illustrated in Figure 8.5-1. Data on the location and type of developments were obtained from the following sources:

- Mackenzie Valley Land and Water Board: permitted and licensed activities within the NWT;
- Indian and Northern Affairs Canada: permitted and licensed activities within the NWT and Nunavut;
- Indian and Northern Affairs Canada: contaminated sites database;
- Natural Resources Canada: obtained a GIS file of community locations from Natural Resources Canada's GeoGratis website;
- GNWT: location of parks within the NWT;
- Saskatchewan government: information related to location of mines and other developments that may occur within the caribou study area;
- individual operators for project-specific information such as component footprints or routes;
- company websites; and
- knowledge of the area and project status.

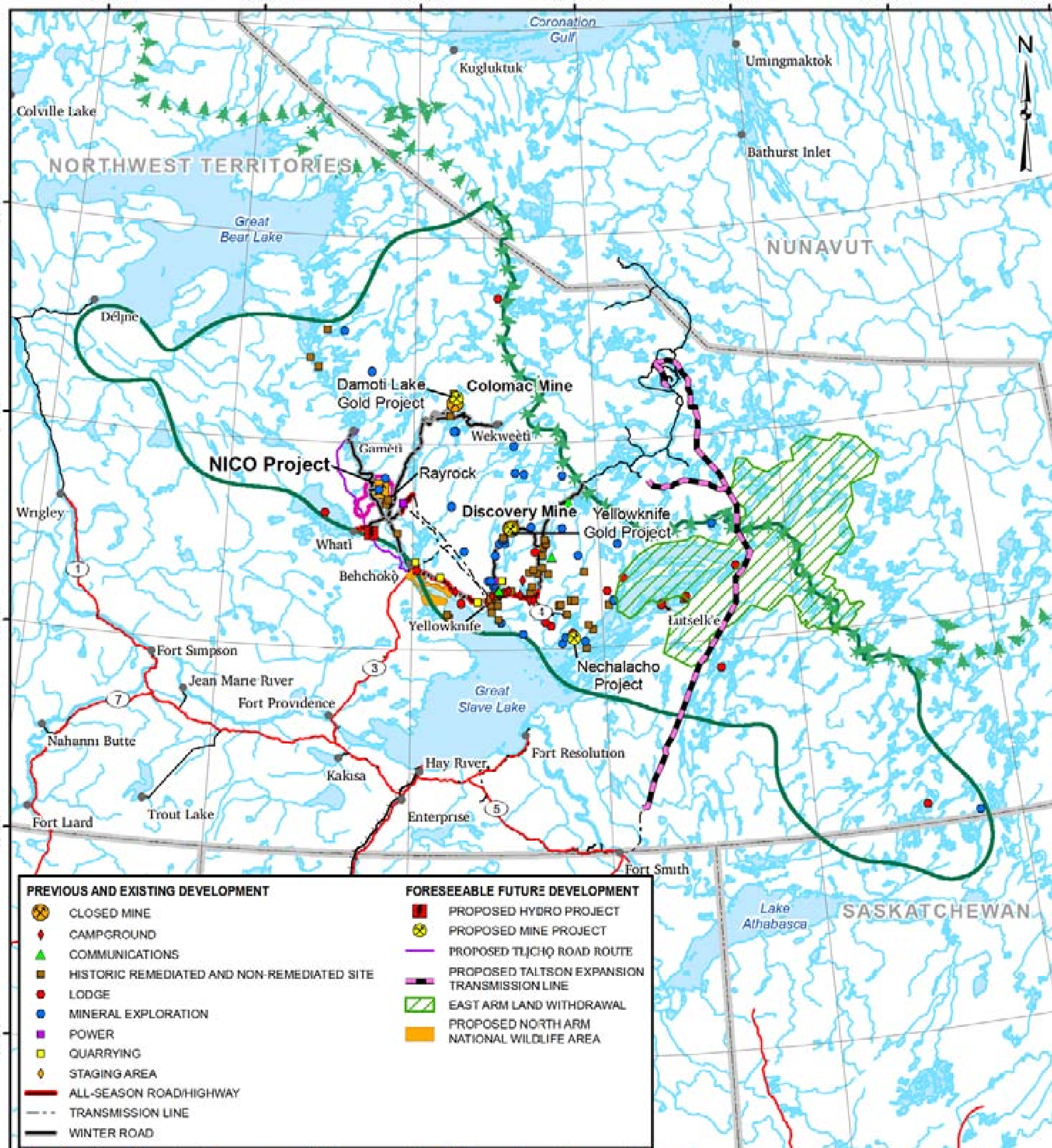
Table 8.5-1: Previous and Existing Developments in the Bathurst Caribou Study Area

Development Type	Feature Area (ha)	Number of Developments	Linear Feature Length (km)
Campground	138.1	11	n/a
Communications (e.g., microwave tower)	37.7	3	n/a
Community	5 683.6	7	n/a
Historical remediated / non-remediated sites[a]	577.7	50	n/a
Lodge (outfitters, tourism)	213.5	17	n/a
Mineral exploration	2 678.5	35	n/a
Operating / closed mine	759.1	2	n/a
Power	157.0	2	n/a
Quarrying	62.8	5	n/a
Staging area (equipment or material storage)	12.6	1	n/a
Transmission lines	3 268.2	3	327
Winter road segments	9 144.3	13	927
All season road/highway segments	2 370.5	6	237
Total Disturbance[b]	**25 103.6**	**155**	**1 491**

[a] includes moderate and high risk contaminated sites (e.g., Rayrock and Colomac mine sites).

[b] includes overlap of footprints.

ha = hectare; km = kilometre; n/a = not applicable.



120°0'0"W 116°0'0"W 112°0'0"W 108°0'0"W

LEGEND

- NICO PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING WINTER ROAD
- RAILROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- TREELINE
- CARIBOU STUDY AREA
- REGIONAL STUDY AREA

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Development data obtained from INAC, MVLWB, and GNWT.
Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

PREVIOUS, EXISTING, AND REASONABLY FORESEEABLE DEVELOPMENTS IN THE CARIBOU STUDY AREA

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-056-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	JV	27 July 2010	
GIS	ANK	03 Apr. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.5-1

Some temporal data were available prior to 1996, but most of the known start and end dates of land use permits for developments were from 1996 through 2010. The file was examined for duplication of information (e.g., a water license and a land use permit for the same development). In cases where 2 or more pieces of location information for the same activity were present, the extra information was deleted from the file so that it contained only 1 point per development. Data associated with the location attributes (e.g., permit status, feature name) also were edited in some instances to update the information for running modelling scenarios efficiently. The information was used to generate a spatially and temporally-explicit development layer within a GIS platform.

The database contains no information on the size of the physical footprint for developments. For communities, and closed mines, the footprint was digitized from Landsat 7 Imagery from the Government of Canada (NRC 2007). A 500 m radius was used to estimate the area of the footprint for exploration sites and the power stations (78.5 ha), which likely overestimates the amount of habitat directly disturbed by exploration activities. Exploration programs typically contain temporary shelters for accommodations and storage of equipment, and are elevated to limit the amount of disturbance to the soil and vegetation. Drilling is usually carried out with portable drill rigs (5 x 5 m area) at 1 location at a time. A 200 m radius (12.6 ha) was used to estimate the size of the remaining point development footprints (such as historical remediated and non-remediated sites [e.g., Colomac and Rayrock mine sites], and a 200 m corridor was used for linear features (Table 8.5-2).

Table 8.5-2: Hypothetical Footprints for Previous, Existing, and Future Developments in the Caribou Study Area

Development Type	Feature Type[a]	Footprint Extent (m)
Campground	Point	200
Communications (e.g., microwave tower)	Point	200
Community	Polygon	actual
Historical remediated / non-remediated sites	Point	200
Lodge (outfitters, tourism)	Point	200
Mineral exploration	Point	500
Operating / closed mine	Polygon	actual
Power	Point	500
Quarrying	Point	200
Staging area (equipment or material storage)	Point	200
Transmission line	Linear	200
Winter road	Linear	200
All season road/highway	Linear	200

[a] Footprints estimated with the exception of mine operations and communities, which were delineated and digitized from remote sensing imagery.

m = metre

For the NICO Project, the Lease Boundary was used rather than the actual footprint, which is conservative and overestimates the changes in habitat amount and fragmentation. For example, the anticipated area of the NICO Project footprint (including the NPAR) is approximately 485 ha (Section 13.4). The area used in the habitat fragmentation (and habitat quality) analysis was approximately 1860 ha. For all developments (including the NICO Project), the physical footprint was carried through the entire effects analysis as it was assumed that direct disturbance to the landscape had not yet been reversed (Section 6.5.2.2). Footprints with overlapping areas on the landscape were not counted twice. The development layer was then applied to the landscape classification of the caribou study area for the baseline, application, and future cases (Table 8.5-3).

Table 8.5-3: Contents of Each Assessment Case

Baseline Case	Application Case	Future Case
Range of conditions from little or no development to all previous and existing projects[a] prior to the NICO Project	Baseline case plus the NICO Project	Application case plus reasonably foreseeable projects

[a] includes approved projects.

The baseline case included the temporal changes in the number of previous and existing projects known to occur within the winter range of Bathurst caribou, which can include little or no previous development (Section 6.5.2). Environmental conditions on the landscape before human development (i.e., reference conditions) were also included in the analysis. Analyzing a range of temporal conditions on the landscape is fundamental to understanding the cumulative effects of increasing development on caribou. The application case occurs during the anticipated year of construction of the NICO Project, through the duration of predicted effects (i.e., until the effects are reversed or are deemed irreversible).

The future case includes the baseline case, application case, and reasonably foreseeable developments (Section 6.5.2). Currently, there are 8 reasonably foreseeable developments that may generate incremental and cumulative changes on vegetation ecosystems (habitat) in the caribou study area:

- Proposed Tłįchǫ Road Route;
- Taltson Hydroelectric Expansion Project;
- Nailii Hydro Project;
- Yellowknife Gold Project at the Discovery Mine site;
- Nechalacho Project at Thor Lake;
- Damoti Lake Gold Project.
- North Arm National Wildlife Area; and
- East Arm National Park.

The temporal boundary for cumulative effects from future developments is a function of the duration of effects from the NICO Project on caribou populations. At a minimum, the time period for effects from the NICO Project, and reasonably foreseeable developments would occur over 21 years (construction through closure). Except for the Proposed Tłįchǫ Road Route and the Taltson Hydroelectric Expansion Project (for which the anticipated footprints are more certain), effects analyses for the future case are mostly qualitative due to the large degree and number of uncertainties. There are uncertainties associated with the rate, type, and location of developments in the seasonal ranges. There are also uncertainties in the direction, magnitude, and spatial extent of future fluctuations in vegetation (i.e., habitat), independent of NICO Project effects. Consequently, potential cumulative effects from reasonably foreseeable developments (future case) other than the Proposed

Tlicho Road Route and Taltson Hydroelectric Expansion Project are discussed in the section on uncertainty (Section 8.9).

Landscape metrics were determined for the reference, 2010 baseline, application, and future case. As mentioned above, reference conditions represent the initial period of baseline conditions (as far back as data are available). Here, the 2010 baseline case includes all previous, existing, and approved developments up to 2010, and includes the existing winter access road used during exploration for the NICO Project.

The incremental and cumulative changes from the NICO Project and other developments on the loss and fragmentation of habitat were estimated by calculating the relative difference between the 2010 baseline case and reference case, between the application and 2010 baseline case, and between the future and application case. The following equations were used:

- (2010 baseline value – reference value) / reference value
- (application value – 2010 baseline value) / 2010 baseline value
- (future case – application value) / application value

The resulting value was then multiplied by 100 to give the percent change in a landscape metric for each comparison. The result provides both 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 (and potential reduction in carrying capacity). Alternately, a negative value for mean distance to nearest neighbour indicates an increase in patch connectivity (and possible increase in travel efficiency for caribou and other wildlife). Absolute values for landscape metrics for each habitat and assessment case (i.e., reference, 2010 baseline, application, and future) are provided in Appendix 8.I.

8.5.2.2 Results

The total area of the NICO Project footprint (including the NPAR) is estimated to be 485.4 ha; however, because the NICO Project Lease Boundary was used in the analyses, and the width of the NPAR was increased to match the raster cell size (200 m) in the land cover classification, the estimated NICO Project footprint for analysis is 1860 ha. The NICO Project will reduce less than 0.1% of the 2010 baseline landscape. Previous and existing developments have removed 0.2% of habitat within the winter range relative to reference conditions. The combined loss of all habitats in the winter range from the Proposed Tłįchǫ Road Route and Taltson Hydroelectric Expansion Project (future case) is less than 0.1%. The cumulative direct disturbance from the NICO Project and previous, existing, and future developments is predicted to be a little more than 0.2% relative to reference conditions. Although progressive reclamation will be integrated into mine planning as part of Fortune's design for closure policy, subarctic ecosystems are slow to recover from disturbance. The Flooded Open Pit, constructed wetlands, Seepage Collection/Surge Ponds, and ditches will be permanent features on the landscape, covering approximately 84 ha.

Under reference conditions, the winter range is mainly composed of coniferous cover (28%), deep water (23%), and burns (22%). The shrub land cover type makes up about 7% of the winter range. Bryoids (wetlands) and bog/fen complexes (treed and herbaceous wetlands) compose about 8% of the landscape, while broadleaf and mixedwood (deciduous) habitats constitute 4% of the winter range. Open and sparsely vegetated bedrock areas represent 6% of the study area (Table 8.5-4). Human development (i.e., communities) composes less than 0.1%

of the study area. Preferred habitats by caribou on the winter range include coniferous forest, and bog/fen and bryoid land cover types (Sections 8.3.2.1.2 and 8.5.3.1).

Previous and existing human developments in the study area have resulted in small reductions of habitat for caribou (Table 8.5-4). Under 2010 baseline conditions, the largest decline in area since reference conditions has been bedrock cover (0.4%) and broadleaf forest cover (0.4%). With the application of the NICO Project, the area per habitat type declines by less than 0.1%. The largest incremental decline from future developments (Proposed Tłįchǫ Road Route and Taltson Hydroelectric Expansion Project) is expected to be 0.1% of coniferous and mixedwood habitats. The cumulative decrease in any particular land cover type from the NICO Project and previous, existing, and future developments is expected to be no larger than 0.5%, and bedrock and broadleaf habitats are affected most (Table 8.5-4). These habitat types are not essential for the life history requirements of overwintering caribou (Section 8.3.2.1.2; Appendix 8.II). Decreases in water (ice) are due to the temporary disturbance from winter roads.

Previous and existing human developments on the landscape also have contributed to small changes in the configuration of caribou habitat (i.e., fragmentation of habitat). From reference to 2010 baseline conditions, the largest decline in the number of patches per habitat type was 0.1% for bog/fen, broadleaf, mixedwood, and shrub habitats, and the largest increase in mean distance to nearest neighbour was 0.1% for bogs/fens. With the application of the NICO Project, the number of patches per habitat type declines by less than 0.1%, and the mean distance to nearest neighbour decreased by less than or equal to 0.2% (Table 8.5-4). Under the future scenario, the incremental decline in number of patches for a given habitat will be less than 0.1%, except for burns, which is expected to increase by 0.5%. Overall, the magnitude of the cumulative change in the configuration of each habitat type from the NICO Project and previous, existing, and future developments is expected to be no larger than 1.7% (i.e., the estimated increase in the number of burn patches and the mean distance between burn patches) (Table 8.5-4).

The presence of the NPAR may represent a barrier to some individuals within the population, particularly during the winter construction phase when vehicle traffic is predicted to substantially increase. For example, roads may contribute to fragmentation of populations through both increased mortality and modifications of behaviour that makes animals less likely to cross roads (Trombulak and Frissell 2000; Dussault et al. 2006; Laurian et al. 2008). In some cases, roads appear to be “leaky barriers” (some animals do manage to cross successfully) but they may nevertheless restrict the regional-scale dynamics of species (Treweek 1999).

Table 8.5-4: Change (percent) in Area and Configuration of Habitat Types from Development within the Caribou Study Area during Baseline, Application, and Future Conditions

Habitat Type	Area (ha) Reference	% Change Reference to 2010 Baseline	% Change 2010 Baseline to Application	% Change Application to Future	% Cumulative Change from Reference
Burn	4 749 292	-0.1	<-0.1	<-0.1	-0.2
Bog/Fen	969 784	-0.2	<-0.1	<-0.1	-0.2
Broadleaf	354 528	-0.4	0	<-0.1	-0.4
Bryoids	760 908	<-0.1	<-0.1	<-0.1	<-0.1
Coniferous	6 015 572	-0.1	<-0.1	-0.1	-0.2
Bedrock	1 330 464	-0.4	<-0.1	<-0.1	-0.5
Mixedwood	448 824	-0.1	<-0.1	-0.1	-0.2
Shrub	1 605 168	-0.1	<-0.1	<-0.1	-0.1
Water (ice)	4 865 140	-0.2	<-0.1	<-0.1	-0.2
Habitat Type	**Number of Patches Reference**	**% Change Reference to 2010 Baseline**	**% Change 2010 Baseline to Application**	**% Change Application to Future**	**% Cumulative Change from Reference**
Burn	1 199	1.0	0.2	0.5	1.7
Bog/Fen	104 898	-0.1	<-0.1	<-0.1	-0.1
Broadleaf	45 829	-0.1	0	<-0.1	-0.1
Bryoids	63 562	<-0.1	<-0.1	0	<-0.1
Coniferous	91 865	0.2	<-0.1	<-0.1	0.3
Bedrock	113 593	0.1	<-0.1	<-0.1	0.1
Mixedwood	60 927	-0.1	<-0.1	<-0.1	-0.1
Shrub	132 334	-0.1	<-0.1	<-0.1	-0.1
Water (ice)	109 664	0.1	<-0.1	<-0.1	0.1
Habitat Type	**Mean Distance to Nearest Neighbour (m) Reference**	**% Change Reference to 2010 Baseline**	**% Change 2010 Baseline to Application**	**% Change Application to Future**	**% Cumulative Change from Reference**
Burn	1 789	-0.9	-0.2	-0.6	-1.7
Bog/Fen	611	0.1	<-0.1	<-0.1	0.1
Broadleaf	713	<-0.1	0	<-0.1	<-0.1
Bryoids	594	<-0.1	<-0.1	<-0.1	<-0.1
Coniferous	500	<-0.1	<-0.1	<-0.1	<-0.1
Bedrock	569	<-0.1	<-0.1	<-0.1	<-0.1
Mixedwood	643	<-0.1	<-0.1	<-0.1	<-0.1
Shrub	543	<-0.1	<-0.1	<-0.1	<-0.1
Water (ice)	531	<-0.1	<-0.1	<-0.1	<-0.1

'<' implies change approaches zero; ha = hectare; m = metre; % = percent.

8.5.3 Habitat Quality, Behaviour, and Movement

8.5.3.1 Methods

In addition to direct habitat effects, changes to habitat quality from the NICO Project and other developments have the potential to indirectly affect the population size and distribution of caribou through sensory disturbance, which can alter the movement and behaviour of individuals. The quality of habitat in the Bathurst caribou winter range below the treeline was classified using a combination of a novel resource selection function (RSF) developed specifically for the NICO Project (Appendix 8.II), a human development database (described in Section 8.5.2.1), and the best available land cover dataset for the caribou study area, which was the Earth Observation for Sustainable Development (EOSD) data (Wulder 2002). The EOSD database classified the landscape into various land cover types at a 25 m resolution (Appendix 8.II), and was incorporated into a GIS platform. Data describing the spatial distribution of fires over time were also compiled and combined with the EOSD land cover database. Burn data were compiled from available fire polygons for the NWT (N. Mair, NWT Centre for Geomatics, 2009, pers. comm.). All vegetation data were based on the year 2000, which represents the most accurate source of vegetation data for the EOSD (Wulder 2002). Upon joining layers, the dataset was re-sampled to 100 x 100 m cell sizes using a nearest neighbour algorithm. For application of the RSF, cover-specific raster grids were generated representing densities of cover at 2 spatial scales (300 m and 15 km; Appendix 8.II). Based on the density rasters and the RSF coefficients in Table 8.5-5, resource selection values were generated per cell across the caribou study area. In this case, the raster grid represented the reference condition for the caribou study area.

Table 8.5-5: Coefficients and 95% Confidence Intervals from a Resource Selection Model for the Bathurst Caribou Winter Range (Caribou Study Area)

Super-classes (EOSD land cover classes)	Coefficient	Lower 95% CI	Upper 95% CI	Preference (P) / Avoidance (A)
Local-scale[a]				
Wetland (bryoids, bog/fen)	8.95	5.82	12.08	P
Conifer	3.36	1.12	5.60	P
Deciduous (broadleaf, mixedwood)	-18.25	-23.86	-12.64	A
Water	-8.62	-10.72	-6.52	A
Burn	-11.84	-13.91	-9.77	A
Regional-scale[b]				
Wetland (bryoids, bog/fen)	-22.48	-31.59	-13.37	A
Conifer	5.22	-0.92	11.36	--[c]
Deciduous (broadleaf, mixedwood)	-50.79	-66.93	-34.66	A
Water	-4.68	-10.89	1.53	--[c]
Burn	2.79	-14.85	20.43	--[c]

Note: coefficients were multiplied by 1000 for illustration purposes.

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

[c] 95% confidence interval (CI) included zero suggesting that the habitat was neither preferred or avoided relative to availability in the caribou study area.

Indirect effects from disturbance, which were based on hypothetical (not modelled) disturbance coefficients and ZOIs, were determined by applying the development layer (Section 8.5.2.1) to the predicted RSF model for the reference condition landscape. Hypothetical disturbance coefficients provided a surrogate to modelled coefficients and were consistent with previous efforts to estimate effects from development on habitat quality for caribou (Johnson et al. 2005). Disturbance coefficients reduce habitat quality within each defined ZOI. For example, a disturbance coefficient of 0.05 implies that habitat quality was reduced by 95% of the original value. Values of disturbance coefficients were based on the published literature (Johnson et al. 2005; Table 8.5-6). Hypothetical disturbance coefficients and ZOIs were also used because the analysis completed during generation of the RSF indicated that the current extent of human development in the caribou study area did not statistically influence the distribution and habitat selection of caribou (Appendix 8.II). Nevertheless, the objective of this section of the DAR was to estimate the potential incremental and cumulative changes in caribou habitat from the NICO Project and other developments using a set of disturbance coefficients and ZOIs that are based on information from empirical studies (Section 8.3.2.1.1; Appendix 8.II).

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. For example, the effects of multiple coefficients at the same location were not multiplied. The coefficient with the strongest effect was applied where ZOIs overlapped, which increased certainty that the predicted effect would not be underestimated. In addition, 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 5 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 5 years. The assumption likely overestimates the effect from exploration activities, as exploration typically does not occur throughout the year. For all closed mines and inactive land use permits, the physical footprint was carried through the entire effects analysis as it was assumed that direct disturbance to the landscape had not yet been reversed.

Table 8.5-6: Disturbance Coefficients and Associated Zones of Influence for Development Activities in the Bathurst Caribou Study Area

Disturbance Type	Feature Type	Footprint		ZOI Range 1		ZOI Range 2		ZOI Range 3	
		Extent (m)[c]	DC	Range[d] (km)	DC	Range (km)	DC	Range (km)	DC
Campgrounds	point	200	0	n/a	n/a	n/a	n/a	n/a	n/a
Communications	point	200	0	0 to 1	0.9	n/a	n/a	n/a	n/a
Community	polygon	actual	0	0 to 1	0.05	1 to 5	0.5	5 to 15	0.75
Historical remediated / non-remediated sites[a]	point	200	0	n/a	n/a	n/a	n/a	n/a	n/a
Lodge (outfitters, tourism)	point	200	0	0 to 5	0.1	n/a	n/a	n/a	n/a
Mineral exploration	point	500	0	0 to 1	0.5	1 to 5	0.75	n/a	n/a
Operating mine	polygon	actual	0	0 to 1	0.05	1 to 5	0.5	5 to 15	0.75
Power	point	500	0	0 to 1	0.5	n/a	n/a	n/a	n/a
Quarry	point	200	0	0 to 5	0.75	n/a	n/a	n/a	n/a
Staging area	point	200	0	0 to 5	0.75	n/a	n/a	n/a	n/a
Transmission line[b]	line	100	0.25	0 to 1	0.5	1 to 5	0.75	n/a	n/a
All season road	line	100	0	0 to 1	0.05	1 to 5	0.75	n/a	n/a
Winter road	line	100	0	0 to 1	0.05	1 to 5	0.75	n/a	n/a

Note: DC and ZOI values were guided by published literature (Johnson et al. 2005; Weir et al. 2007; Boulanger et al. 2009).

[a] from Indian and Northern Affairs Canada contaminated sites database (classified as medium and high risk sites).

[b] DC and ZOI for transmission lines based on results reported in Mahoney and Schaefer (2002), Vistnes and Nelleman (2001) and Nelleman et al. (2003).

[c] footprints estimated with the exception of communities and closed mines, which were delineated and digitized from remote sensing imagery.

[d] from edge of measured or hypothetical footprint.

n/a = not applicable; DC = disturbance coefficients; ZOI = zone of influence; m = metre; km = kilometre.

Direct and indirect effects from human disturbance were used to quantify changes in the relative availability of different quality habitats during different periods of increasing and decreasing development during baseline conditions (i.e., reference, 2006, and 2010), application of the NICO Project, and future conditions. The number of developments in the caribou study area has changed over time and a key driver of this change has been the number of mineral exploration camps (Figure 8.5-2).

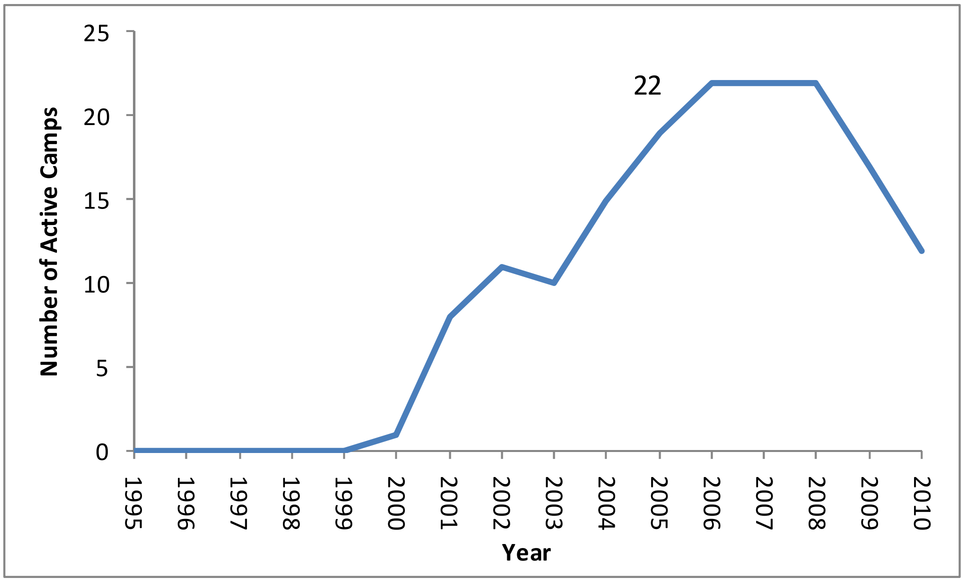


Figure 8.5-2: Annual Trends in the Number of Active Mineral Exploration Camps in the Caribou Effects Study Area

After the habitat (raster) map was completed for the reference landscape (no development except communities), the raster cells were divided into 4 categories (high, good, low, and poor) of approximate equal area (delineated by quartiles). Upon application of each development scenario, the relative quantity of different quality habitats were calculated as was done for the reference case using the 4 categories of suitability. The following equations were used to estimate the relative change in the amount of different quality habitats in the caribou study area for different conditions on the landscape:

- (2006 baseline area – reference area) / reference area x 100
- (2010 baseline area – 2006 baseline area) / 2006 baseline area x 100
- (application case area – 2010 baseline area) / 2010 baseline area x 100
- (future case area – application case area) / application case area x 100

Although the indirect effects from noise are implicitly included in the habitat modelling, the potential effects on caribou from noise are also assessed separately. Mining activities and associated infrastructure generate noise that may influence the movement and behaviour of caribou. Sensory disturbance can result in increased levels of stress and energy expenditure, and disruption of feeding behaviour; therefore, a noise assessment (Appendix 8.III) was completed to identify the sound emissions associated with the NICO Project activities and the potential effects on caribou.

During construction, approximately 2200 truck loads will be delivered to the NICO site during the winter road season. This amounts to approximately 63 return trips per day over an average 70 day winter road season. During operations, an estimated 5 to 9 trucks per day are anticipated to travel along the NPAR and Proposed Tłı̨chǫ Road Route. During operations, noise will be generated from mobile and stationary mining equipment, blasting, and aircraft at the NICO Project. Aircraft are anticipated to be used for medical emergencies and the transport of some goods to site (i.e., the annual volume of aircraft traffic is expected to be low [Appendix 8.III]).

The focus of the noise assessment is on determining changes to the existing ambient noise levels due to the NICO Project, and comparing the results with noise regulations and guidelines from North American jurisdictions (Appendix 8.III). Because there are no noise level guidelines for wildlife, human noise level guidelines were applied to predicting effects on caribou. Although noise at the NICO Project site will be produced during the 1-year construction period, the duration and magnitude of noise is expected to be greater during operations. The evaluation of noise effects focused on evaluating the noise levels associated with the fully developed operations. Model scenarios were established to calculate normal NICO Project operations that could potentially increase noise levels (e.g., blasting, crusher, power plant, and auxiliary equipment) (Appendix 8.III). For the NPAR and Proposed Tłı̨chǫ Road Route, the noise assessment focused on the construction phase when the number of vehicles along the roads is expected to be much greater than during operations.

8.5.3.2 Results

The amount of preferred caribou habitat (i.e., high and good quality habitats) in the caribou study area decreased by 5.1% from reference to 2006 baseline conditions (Table 8.5-7). Most of the decline in habitat quality was associated with the increasing number of exploration sites on the landscape (Figure 8.5-2). Relative to 2006 baseline conditions, there was a 0.3% increase in high quality habitat in 2010 (Table 8.5-7). This is likely due to the decrease in the number of active mineral exploration camps in the winter range (Figure 8.5-2). The application of the NICO Project is expected to decrease good and high quality habitat by 0.4% relative to 2010 baseline conditions. Future developments (Proposed Tłı̨chǫ Road Route and Taltson Hydroelectric Expansion Project) are expected to decrease good and high quality habitat by 1.0% relative to the application case. The cumulative loss of good and high quality habitat from reference conditions to the future case is expected to be 6.1%. Figures 8.5-3 to 8.5-7 illustrate changes in habitat quality on the winter range from reference to future development conditions.

Table 8.5-7: Relative Changes in the Availability of Different Quality Habitats for Bathurst Caribou Winter Range from Reference to Reasonably Foreseeable Projects

Habitat Quality	Habitat Area for Reference Landscape (km^2)	% Change Reference to 2006 Baseline	% Change 2006 to 2010	% Change 2010 to Application	% Change Application to Future	Cumulative % Change Reference to Future
High	52 383.9	-3.5	0.3[a]	-0.5	-1.3	-4.9
Good	52 325.1	-1.6	<-0.1	0.1	0.3	-1.2
Low	53 363.0	-3.4	<-0.1	0.2	-1.0	-4.1
Poor	53 749.0	8.3	-0.2	0.2	1.6	10.1

Note: Percent change per habitat category was calculated as area lost or gained divided by the area of the habitat category in the earlier time period; cumulative values reflect area lost or gained on future landscape divided by area of habitat in the reference landscape.

Reference landscapes (no development) were compared to maps modified by hypothetical disturbance coefficients and zones of influence (i.e., assumed disturbance) for active developments.

2006 and 2010 Baseline = incremental changes from previous and existing developments.

Application case = NICO Project plus 2010 baseline conditions.

Future case = Taltson Hydroelectric Expansion Project and Proposed Tłı̨chǫ Road Route plus the application case.

[a] Increases in high or good quality habitats may be due to expiration of exploration permits (i.e., only direct effects from footprint remain following exploration); for example, the number of active mineral exploration camps declined from 16 to 6 camps from 2006 to 2010.

'<' implies change approaches zero; km^2 = square kilometres; % = percent.

Noise sources from the NICO Project include mobile and stationary mining equipment, blasting, aircraft, and vehicles along the NPAR, existing winter roads, and the Proposed Tłı̨chǫ Road Route. The recommended maximum value for the nighttime noise level for undeveloped areas is 40 dBA (ERCB 2007) (Appendix 8.III). This is the average nighttime (23:00 to 07:00) sound level L_{eq} that includes both human-related noises and the ambient sound level (existing sound levels without human-related noises). The typical nighttime ambient sound level in rural Alberta is 35 dBA L_{eq} with higher winds, precipitation, and thunder being the principal sources of increases above this value (ERCB 2007). During daytime hours these levels can be higher, due to higher levels of human activity and associated tolerance for noise levels. The predicted noise levels from the various NICO Project activities are compared with benchmarks in Table 8.5-8. The results show that noise predictions slightly exceed benchmarks for mine operations, and are below benchmarks for the NPAR and Airstrip.

Table 8.5-8: Summary of Noise Levels from the NICO Project

Receptor	Mine Operations[a] L_{eq} (dBA)		NICO Project Access Road L_{eq} (dBA)		Airstrip L_{max} (dBA)	
	Prediction	Benchmarks	Prediction	Benchmarks	Prediction	Noise Event Benchmarks
1.5 km criteria boundary location[b]	43.0	40[c]	36.2	40[c]	93.0	NA

[a] highest cumulative noise levels calculated at each receptor.

[b] location with highest predicted noise level along the length of the NICO Project Lease Boundary.

[c] ERCB (2007).

dBA = A-weighted decibel; km = kilometre; ≥ = greater than or equal to; L_{eq} = equivalent continuous sound and noise level; L_{max} = maximum sound and noise level; NA = not applicable.

A summary of the maximum distances for NICO Project noise to attenuate to background levels are shown in Table 8.5-9. The distances indicate the area within which NICO Project-related noises may be found to be distinguishable from the natural environment by people. When NICO Project noise predictions diminish to levels below background, they are not expected to be distinguishable from natural noises. The distance for noise attenuation to background levels for core mining operations (including blasting) is 3.3 km, but disturbance from blasting is anticipated to be infrequent (occur once per day). The distance for noise attenuation to reach background levels from the Airstrip is about 26 km (Table 8.5-9); however, disturbance from large aircraft is expected to be infrequent (Appendix 8.III) and short-term (less than 5 minutes in duration). The distance for noise attenuation to background for traffic along the existing winter roads and the NPAR during the construction phase is 0.9 km (Appendix 8.III). Similarly, noise from vehicles along the Proposed Tłı̨chǫ Road Route is predicted to decrease to ambient levels within 1 km of the right-of-way.

Table 8.5-9: Distance for Noise Attenuation to Background Sound Levels for the NICO Project

Background Noise Level	Mine Operations (km)	NICO Project Access Road (km)	Airstrip (km)
Continuous (35 dBA)	3.3[a]	0.9[b]	NA
Noise Event	NA	NA	25.8

[a] based on the distance to the nearest noise sources.

[b] based on maximum pass-by level.

dBA = decibels; km = kilometre; NA = not applicable.

LEGEND

- TERRITORIAL CAPITAL
- POPULATED PLACE
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- TREELINE

RESOURCE SELECTION FUNCTION

- HIGH
- GOOD
- LOW
- POOR

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

HABITAT QUALITY FOR CARIBOU IN THE WINTER RANGE: REFERENCE CONDITIONS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-067-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	JV	01 Mar. 2011	**FIGURE: 8.5-3**
GIS	ANK	10 Mar. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

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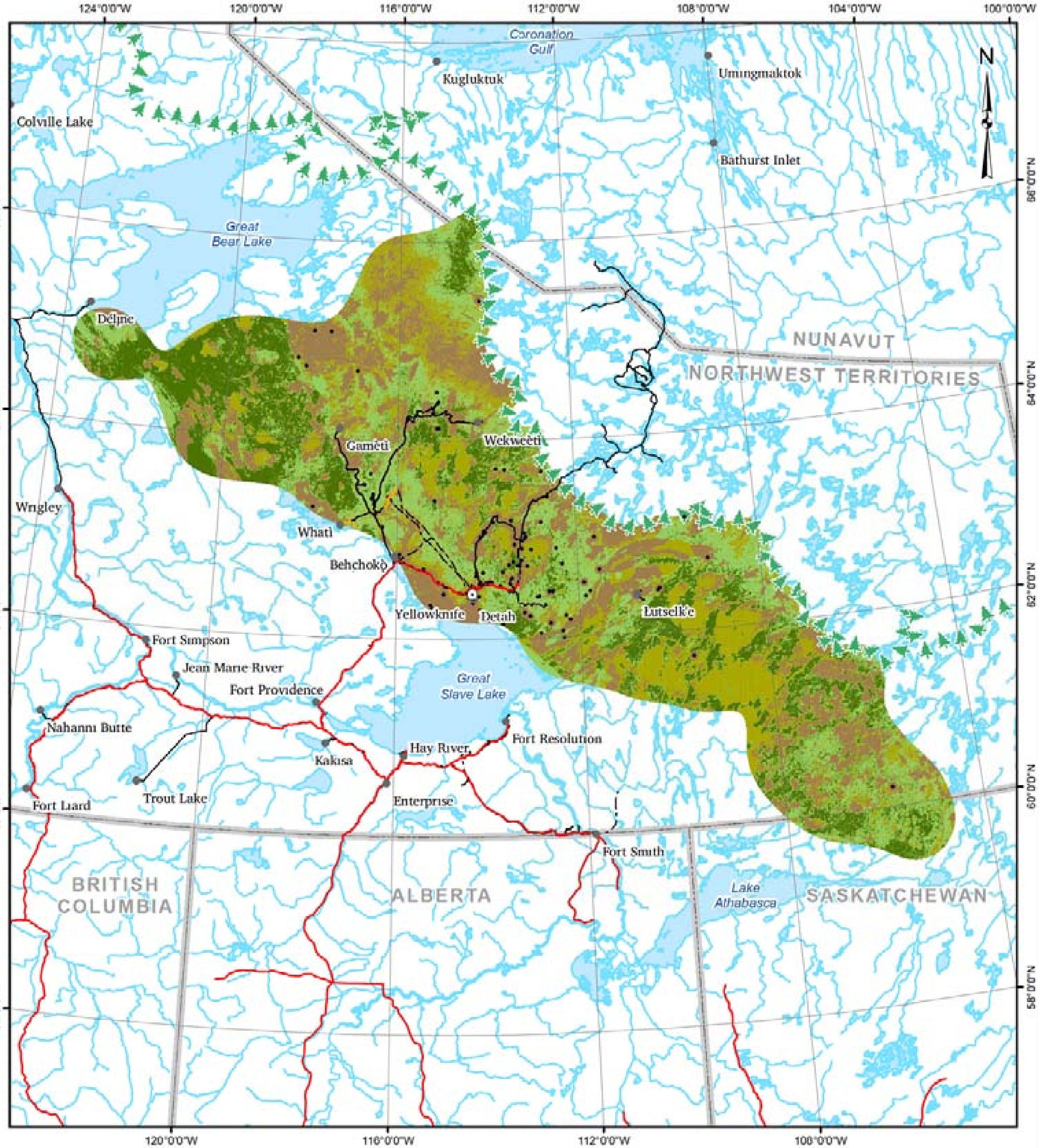

LEGEND

- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- DEVELOPMENT LOCATION
- EXISTING TRANSMISSION LINE
- TREELINE

RESOURCE SELECTION FUNCTION

- HIGH
- GOOD
- LOW
- POOR

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

HABITAT QUALITY FOR CARIBOU IN THE WINTER RANGE: 2006 BASELINE CONDITIONS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-058-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	JV	01 Mar. 2011	
GIS	ANK	10 Mar. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

FIGURE: 8.5-4

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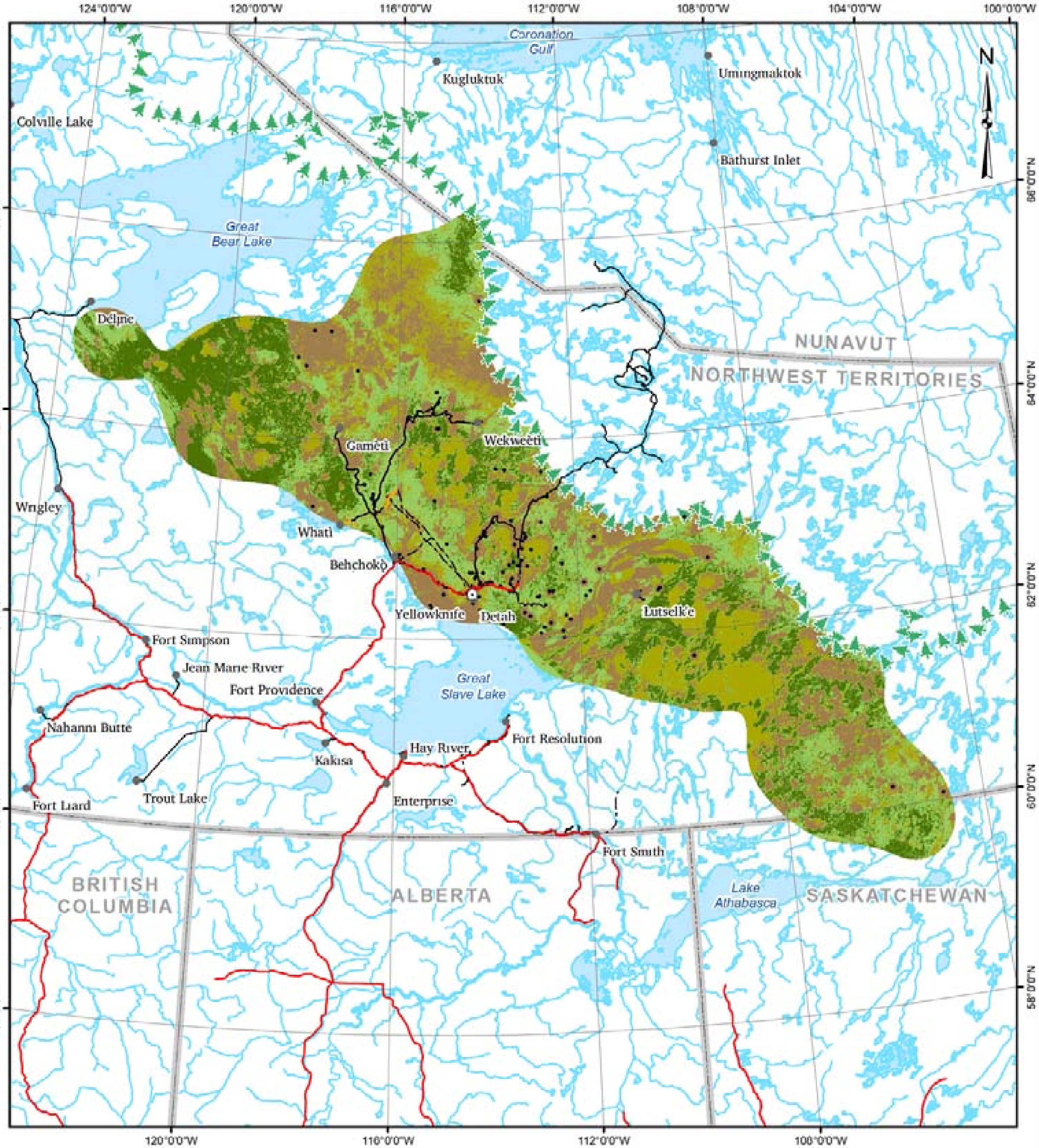

LEGEND

- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- DEVELOPMENT LOCATION
- EXISTING TRANSMISSION LINE
- TREELINE

RESOURCE SELECTION FUNCTION

- HIGH
- GOOD
- LOW
- POOR

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

HABITAT QUALITY FOR CARIBOU IN THE WINTER RANGE: 2010 BASELINE CONDITIONS

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-059-GIS				
PROJECT No. 09-1373-1004		SCALE AS SHOWN		REV. 0
DESIGN	JV	01 Mar. 2011	**FIGURE: 8.5-5**	
GIS	ANK	10 Mar. 2011		
CHECK	GRA	03 Apr. 2011		
REVIEW	GRA	03 Apr. 2011		

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LEGEND

- NICO PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- DEVELOPMENT LOCATION
- EXISTING TRANSMISSION LINE
- TREELINE

RESOURCE SELECTION FUNCTION

- HIGH
- GOOD
- LOW
- POOR

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

HABITAT QUALITY FOR CARIBOU IN THE WINTER RANGE: APPLICATION CASE

Golder Associates
Edmonton, Alberta

FILE No. EA-Wild-060-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	JV	01 Mar. 2011	**FIGURE: 8.5-6**
GIS	ANK	10 Mar. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

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LEGEND

- NICO PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- EXISTING ALL-WEATHER ROAD
- EXISTING WINTER ROAD
- PROPOSED NICO PROJECT ACCESS ROAD
- PROPOSED TŁĮCHǪ ROAD ROUTE
- TERRITORIAL/PROVINCIAL BOUNDARY
- WATERCOURSE
- WATERBODY
- DEVELOPMENT LOCATION
- EXISTING TRANSMISSION LINE
- PROPOSED TALTSON EXPANSION TRANSMISSION LINE
- TREELINE

RESOURCE SELECTION FUNCTION

- HIGH
- GOOD
- LOW
- POOR

200 0 200

SCALE 1:6,000,000 KILOMETRES

REFERENCE

Base data obtained from Atlas of Canada, DMTI, and ESRI.
Projection: Canada Lambert Conformal Conic

FORTUNE MINERALS LIMITED
NICO DEVELOPER'S ASSESSMENT REPORT

TITLE

HABITAT QUALITY FOR CARIBOU IN THE WINTER RANGE: FUTURE CASE

FILE No. EA-Wild-061-GIS			
PROJECT No. 09-1373-1004		SCALE AS SHOWN	REV. 0
DESIGN	JV	01 Mar. 2011	
GIS	ANK	10 Mar. 2011	
CHECK	GRA	03 Apr. 2011	
REVIEW	GRA	03 Apr. 2011	

Golder Associates
Edmonton, Alberta

FIGURE: 8.5-7

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In Alaska, caribou that were disturbed by low altitude overflights of jet aircraft travelled further and were more active than undisturbed caribou (Maier et al. 1998). Caribou were most sensitive to jet noise during the post-calving season and least sensitive to jet disturbance during the winter season. Woodland caribou in northern Alberta were found to move faster, but not further distances, when subjected to loud noises (Bradshaw et al. 1997). Calef et al. (1976) observed that barren-ground caribou in Yukon and Alaska reacted most strongly when aircraft were less than 150 m above ground level. Similarly, Harrington and Veitch (1991) found that woodland caribou in Labrador had a more adverse response to low-level aircraft overflights.

8.5.4 Effects on Behaviour, Energy Balance, and Calf Production

8.5.4.1 Methods

Barren-ground caribou herds regularly show large fluctuations in population size. The size of the Bathurst herd has declined rapidly in the past 5 years, which is likely related to high mortality rates and previous years of failed recruitment of calves into the adult portion of the population (Nesbitt and Adamczewski 2009; Adamczewski et al. 2009). There are many factors that can contribute to the decline, and the dynamics of the herd are complex. A recent workshop incorporating scientific information and Traditional Knowledge identified fire on the winter range, disease, timing of spring, predators, hunter harvest, as well as human development as possible contributing factors (Nesbitt and Adamczewski 2009; Adamczewski et al. 2009). Of these, there is evidence to suggest that the annual caribou harvest has played a key role in accelerating the rate of decline in recent years. There is no level of calf recruitment that can compensate for current estimated cow survival rates (67 to 68%; Adamczewski et al. 2009).

The objective of the analysis here is to simulate the natural range in variation in demography and habitat conditions (with an emphasis on the winter range), and to predict the relative contribution of factors underlying the decline of the herd during the past 10 to 15 years. Specifically, the analysis is intended to better understand effects from the natural environment and human developments on caribou body condition, which is functionally related to vital rates such as fecundity (i.e., ability to become pregnant in autumn and deliver a calf in spring) and calf survival.

The analysis examines 2 hypotheses. The first hypothesis is that human developments affect fecundity rates by creating sensory disturbances that alter caribou behaviour and energetics during the autumn and winter periods (Bergerud et al. 1984; Cameron et al. 2005). The analysis focused on the autumn season and when animals arrive on their winter range, as this is when opportunities for compensatory growth may exist prior to the onset of winter (Dale et al. 2008). It is thought that caribou may exhibit such adaptations (e.g., increasing food intake prior to winter) to cope with variation in food availability that characterizes their environment (Broekhuizen et al. 1994; Dale et al. 2008).

The second hypothesis is that severe weather during late gestation affects calf survival by creating poor conditions for travel and foraging, resulting in poor body condition, reduced birth weights, and ultimately, reduced calf survival rates (Boertje 1985; Adams et al. 1995; Helle and Kojola 2008). Although other hypotheses related to the decline of the Bathurst herd exist, effects related to human development and spring weather conditions are highlighted because they are relatively well-studied and commonly discussed as contributing factors to the recent decline. To assist with evaluating the hypotheses, energetic models were constructed and were based on previously published research, and when possible, use characteristics of barren-ground caribou in the central Arctic of Canada (e.g., McEwan 1970; Boertje 1985; Fancy and White 1987). Much of the analysis presented below is based on an energy model for adult female caribou of the Denali Herd, Alaska (Boertje 1985).

8.5.4.1.1 Effects from Sensory Disturbance

Reduced rates of female fecundity (i.e., parturition) have been cited as a contributing factor to recent declines in the abundance of the Bathurst herd (Boulanger and Gunn 2007). The autumn/fall rut and early winter seasons are a critical period when animals require access to quality forage to achieve sufficient body condition for survival and reproduction prior to the onset of unfavourable winter conditions (Bradshaw et al. 1998; Johnson et al. 2005). Previous research has shown that the probability of producing a calf varies directly with body weight and fat content of sexually mature females during the previous year (Cameron et al. 1994, 2005). One possible mechanism by which body condition may be negatively affected is through encounters with human developments that result in flight responses and decreased time spent feeding and the associated energetic costs.

There is potential for encounters with developments during the fall and early winter periods when animals initially enter and move around the winter range before becoming more sedentary (Boulanger et al. 2004). For example, an animal in close proximity to a mine or exploration site may encounter noise or visual disturbances from a human walking or working outside, a moving vehicle, blasts, and an aircraft flying overhead. Based on data collected at the Ekati Diamond Mine during 2001 to 2008, 55% of caribou groups showed a behavioural response (e.g., stopped foraging, ran or walked away in the opposite direction) to mine-related disturbances (BHPB 2009).

For the analysis here, costs for an encounter (i.e., a single disturbance event) with an active development were calculated as the sum of energetic costs (mega joules [MJ]) for the initial flight response, additional movements, and the cost of excitement. It was assumed that when animals exhibit a behavioural response they are running or trotting away from the disturbance. Bradshaw et al. (1998) found that disturbed caribou in the boreal forest of Alberta move rapidly from the source for about 15 minutes; however, this is a biologically conservative assumption as responses can vary and be as minor as only looking in the direction of the disturbance (BHPB 2009). A trotting and galloping cost of 0.035 mega joules per kilogram per hour (MJ/kg/h) was used in the analysis.

It was assumed that caribou travelled, on average, 2.11 km farther than non-disturbed animals after a disturbance event (Bradshaw et al. 1998). The cost of this extra travel was calculated as 'walking cost' x 'body weight' x 'distance travelled'. A walking cost of 0.00264 mega joules per kilogram per kilometre (MJ/kg/km) (Boertje 1985) was used in the analysis. The average female caribou body weight was assumed to be 80 kg in the fall (Banfield 1974; Adamczewski et al. 2009).

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 fasting metabolic rates (Blaxter 1962). It was assumed that animals were excited for a 12-hour (one half day) period after an encounter. A daily fasting metabolic rate of 0.403 MJ/kg$^{0.75}$ (McEwan 1970; Fancy and White 1987) was used in this analysis. The cost of excitement was calculated as 0.10 x (80 kg)$^{0.75}$ x fasting metabolic rate x 0.5 days.

To determine the energy equivalent of body weight, endogenous reserves were divided into 2 categories: loss by fat catabolism (90% of reserves) 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 was calculated as total cost of disturbance divided by [(0.9 x 39.3 MJ/kg) + (0.1 x 5.0 MJ/kg) = 35.87 MJ/kg].

The mean autumn mass loss resulting in no reproduction the following spring was set at 20% of an 80 kg female (i.e., 16 kg; Cameron and Ver Hoef 1994). It was assumed that the relationship between autumn body mass and probability of parturition was linear. The proposed relationship is a simplified, but biologically conservative modification of that described in Cameron and Ver Hoef (1994). The number of disturbance events that would result in a 20% mass loss was calculated as 16 kg divided by the approximate mass loss from one disturbance event.

8.5.4.1.2 Effects of Spring Conditions

Another factor influencing vital rates is maternal condition shortly after parturition (i.e., estimated prepartum body weight minus weight of fetus; Cameron et al. 2005; Bergerud et al. 2008). Calf survival depends on parturition date and birth weights (Begerud et al. 2008; Couterier et al. 2009), both of which are highly related to maternal condition during the last 4 to 6 weeks of gestation (month of May; Adamczewski et al. 1987; Bergerud et al. 2008). This is a critical time when the fetus (unborn calf) is growing at a relatively fast rate. Thus, access to forage and unrestricted movements to and on the calving ground are critical for the cow to meet the nutritional requirements for the developing fetus (Bergerud et al. 2008). A late spring green-up and/or snow/ice cover can reduce female condition and the birth weight and survival rate of the calf. The implications for the herd are that calf recruitment and abundance can decline. For example, in the George River herd, the proportion of calves in the population during autumn was highly correlated with average annual birth weight, and varied from 52 calves per 100 females when the herd was increasing to 31 calves per 100 females when the herd was in decline (Couturier et al. 2009).

In the analysis here, potential effects of spring condition on adult female body condition and calf survival were estimated by synthesizing previously completed research and by using a relatively simple energetic model. Energetic costs of poor weather conditions (e.g., hard snow, freezing rain, and ice) during the spring migration considered costs of travel and cratering (digging through snow) for food. Costs were calculated for a 5-week period (35 days) when the animal was assumed to travel approximately 400 km from the winter range to the calving range. First, the energetic cost of walking was estimated as 0.0023 MJ/kg/km, and when walking in snow, costs were estimated as 0.00265 MJ/kg/km. Costs for walking in snow (with sinking depths of 23 centimetres [cm]) were assumed to be only 15% greater than summer values (Boertje 1985). This estimated increase is based on research on white-tailed deer energetics (Mattfield 1973), but considers the following aspects of caribou biology: (i) the relatively large hoof-foot area of caribou, (ii) the single file strategy that caribou use when walking in deep, soft snow, and (iii) that much of the landscape has shallow snow depths or is wind-swept (i.e., lakes, which caribou use for travel during the northern migration). Cratering costs, when applied to proportions of the day spent grazing in winter were assumed to add approximately 1.2 mega joules per day (MJ/d), and assumed that cratering was prolonged and that snow conditions were relatively severe (Boertje 1985).

The extra cost of walking in snow was calculated using the formula:

$$(WS \times BW \times D) - (W \times BW \times D)$$

where WS = the energetic cost of walking in snow, BW = body weight, D = distance travelled from the winter range to the calving range, and W = energetic cost of walking. The extra cost of cratering was calculated as the cost of cratering multiplied by 35 days (i.e., the approximate time period for migration from the winter range to the calving range).

To determine the energy equivalent of body weight, endogenous reserves were divided into 2 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 was calculated as the extra cost of severe snow conditions divided by [(0.9 x 39.3 MJ/kg) + (0.1 x 5.0 MJ/kg)].

In the George River herd, calves were 0.07 kg lighter with every 10 cm increase in snow depth during the winter months. Such losses reduce fetal weight and birth weight of calves (Adamczewski et al. 1987), which is important as the annual average birth mass of calves can strongly influence rate of increase for the herd (Couturier et al. 2009). For example, a 1 kg decrease in birth mass resulted in 10 fewer calves per 100 cows in the George River herd in the fall. Based on this relationship (i.e., 1:10 ratio of decrease in calf birth weight to reduced calf recruitment in population), the decrease in calf survival under a scenario of poor spring conditions was calculated as mass loss of the cow from the extra cost of severe snow conditions divided by 10.

8.5.4.2 Results

The cost of the initial flight response from sensory disturbance was calculated to be 0.7 MJ. An average female caribou was calculated to expend an additional 0.446 MJ of energy because of the extra distance travelled (i.e., 2.11 km) when disturbed. The cost of excitement was calculated to be 0.54 MJ. Thus, total cost of disturbance from an encounter is approximately 1.69 MJ (0.446 MJ for walking + 0.7 MJ for flight response + 0.54 MJ for prolonged excitement). Based on the total energetic cost from an encounter with a disturbance event, mass loss from one disturbance event was calculated to be 0.0471 kg (1.69 MJ / 35.87 MJ/kg). Based on this value, a female caribou would have to come into contact with 340 disturbance events to lose 20% of their body mass, which would result in no reproduction the following spring. Thus, each encounter with disturbance was predicted to reduce the fecundity rate of a female caribou by 0.00294 units, which results in a predicted 0.3% decrease in the fall calf:cow ratio relative to a reference condition (where parturition rate is 90%, spring to fall calf survival is 55.6%, and fall calf:cow ratio is 50%).

The following is an example showing the possible effects to caribou from encountering a number of developments and disturbance events during the autumn and winter seasons. For a landscape in which an individual in the population encounters an average of 40 sensory disturbance events in its winter range, the proposed energetics model predicts that the fecundity rate of the female would be reduced by approximately 0.1176 units (0.00294 x 40 [a weight loss of 1.884 kg]). Of those 40 encounters, approximately 55% of them elicit a flight (trotting or running) response (BHPB 2009). Thus, the overall change in fecundity rates would be smaller, decreasing by 0.0647 units (i.e., a weight loss of 1.036 kg), which results in a 7.1% decrease in the fall calf:cow ratio relative to a reference condition (Table 8.5-10, Scenario 4).

Table 8.5-10: Relative Effects from Spring Conditions and Encounters with Human Developments on Autumn Calf:Cow Ratios

Scenario	Description	Predicted Change to Vital Rate	Predicted Fall Calf:Cow Ratio	Relative Change to Calf:Cow Ratio from Reference Conditions
1	Reference[a]	No change	0.500	No change
2	Severe spring conditions[b]	Calf survival reduced 0.148 units (survival=40.8%)	0.367	-26.6%
3	Moderately severe spring conditions[c]	Calf survival reduced 0.074 units (survival=48.2%)	0.434	-13.2%
4	40 hypothetical disturbance events	Fecundity reduced 0.065 units (parturition=83.5%)	0.464	-7.1%
5	A cumulative effects scenario (Scenarios 3 + 4)	Calf survival reduced 0.074 units and fecundity reduced 0.065 units	0.403	-19.5%

Note: fall ratio of calves to cows was a function of the parturition rate multiplied by the survival rate of calves.

[a] reference scenario used current estimates of vital rates: parturition rate of 90%, calf survival rate of 55.6% and a fall ratio of 50 calves to 100 cows (50%; Adamczewski et al. 2009).

[b] deep snow cover persisting for 35 days.

[c] snow cover persisting for 17.5 days.

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. Furthermore, application of the energetic model to 40 hypothetical encounters is likely an overestimate given that there were about a maximum of 30 active point source developments in the study area during baseline conditions (7 communities, 22 exploration camps, 1 staging area) (Table 8.5-1; Figure 8.5-2). Although lodges/outfitting camps can influence caribou behaviour, these facilities are typically closed before the end of October (i.e., previous non-resident hunting season was from 15 August to 31 October). It is recognized that the length of linear developments, such all-season and winter roads, may result in multiple occurrences of disturbance events; however, all-season and winter roads cover less than 0.2% of the caribou study area (Section 8.5.2.2), and 2 of the primary existing winter roads (i.e., the road from the Tłįchǫ Winter Road to Colomac and the Tibbitt-to-Contwoyto Winter Road) are separated by about 150 km (Figure 8.5-2). Caribou generally restrict their daily home range movements during mid to late winter, and therefore, individuals should encounter fewer disturbances. For example, movement rates are about 50% slower during the winter season (approximately 5 km per day) relative to the post-calving season, with the exception of a slight increase in movement rate during the fall-rut (mid-October to November) (Gunn et al. 2002).

During the migration to the calving grounds in a year with poor spring conditions, the cost of walking in snow was calculated as 11.2 MJ, and the cost of cratering in deep or hard snow was calculated as 42 MJ (total cost of severe snow conditions is 53.2 MJ). Body mass loss in females from the extra cost of severe snow conditions was calculated to be 1.48 kg (53.2 MJ / 35.87 MJ/kg). Based on this mass loss, calf survival is anticipated to decrease by 0.148 units under a scenario of severe spring conditions, which results in a 26.6% decrease in the fall calf:cow ratio relative to a reference condition (Table 8.5-10, Scenario 2). In the occasional year with moderately severe spring conditions and 40 winter disturbance events, the predicted cumulative decrease in the calf:cow ratio is 19.5% relative to a reference condition (Table 8.5-10, Scenario 5). For the infrequent year with severe spring conditions and 40 winter disturbance events, the expected fall calf:cow ratio is 0.341, which is 31.8% lower than the reference condition.

The predicted responses in calf survival and fall calf recruitment due to moderately severe to severe spring conditions is similar to values reported across herds and regions (Table 8.5-10, Scenarios 2 and 3). For the Porcupine herd, high snowfall on the calving ground and coastal plains can reduce calf survival by 19% (Griffith et al. 2002). Helle and Kojola (2008) showed that the ratio of calves to females, approximately 1 month after calving, decreased by 0.01 units with every day that snowmelt was delayed (from 1 May onwards). In other words, if snowmelt is delayed by 30 days, calf survival rates may decrease by 0.30 units. Another example of effects from climate on caribou calf mortality has been documented in Denali National Park, Alaska (Adams et al. 1995). Neonate survival was lower following the high snowfall of winter 1984-1985 when the snowpack persisted throughout the calving season.

Although human developments during autumn and early winter movements in the winter range of the Bathurst herd may affect the demography of the herd, the effect is relatively small compared to weather-related factors (Table 8.5-10). Bergerud et al. (1984) contend that there is little to no evidence that sensory disturbance activities affect herd productivity. Furthermore, information on the current condition of Bathurst cows suggests that animals are in good condition and that pregnancy rates are high (Adamczewski et al. 2009). Pregnancy rates were approximately 100% in March of 2008 and 89% in April of 2009. It is also important to note that recent winter surveys (2008) have shown that calf to cow ratios are higher than recent years, and between 40 and 50 calves per 100 cows for 4 other herds in the NWT (Ahiak, Bluenose East, Bluenose West, and Cape Bathurst) (ENR, unpublished data; Adamczewski et al. 2009). This suggests that large-scale improvements in environmental conditions may be occurring across the landscape. To put the predictions in Table 8.5-10 into perspective, it has been proposed that a fall calf:cow ratio of about 0.30 is associated with stable caribou herds under sustainable harvest levels (Bergerud et al. 2008).

8.5.5 Related Effects to People

Based on the reviewed traditional knowledge and traditional land use information, caribou was and continues to be the most important resource harvested by Aboriginal groups with traditional lands near the NICO Project. Residents of both Whatì and Gamètì identified areas within the RSA for hunting, including areas around Hislop Lake, and the area around Bea Lake and Crowfoot Lake (Section 5.3.2). Gamètì and Whatì interview participants also identified a caribou hunting area near the NPAR between Hislop Lake and Rabbit Lake.

The health of caribou is of concern for Tłįchǫ community members because of the importance of traditional harvesting. There is particular concern with caribou exposure to tailings and increased uptake of chemicals of potential concern from the tailings. As determined in the Wildlife Health Risk Assessment, caribou exposure to chemicals of potential concern as a result of the NICO Project and other current and foreseeable developments was considered to be negligible. A Human Health Risk Assessment was carried out to assess the potential risks to people that may be impacted as a result of the proposed NICO Project. Overall, based on the calculated exposure doses, it is anticipated that aerial depositions and hydrological discharges from the NICO Project will result in no anticipated change in human health outcomes related to the NICO Project in comparison to baseline conditions. The Human Health Risk Assessment predicted negligible changes to chemicals of potential concern concentrations in caribou tissue as a result of the NICO Project. Therefore, there is no anticipated change in human health outcomes related to the NICO Project in comparison to baseline conditions as a result of consumption of caribou.

Traditional knowledge interview participants in Whatì said that the caribou between Hislop Lake and Lac La Martre do not appear healthy. Gamètì Elders indicated that the wildlife near the NICO Project may be affected if the NICO Project is developed. The Elders further noted that caribou migration may also change because of NICO Project-related mining noise, and that other animals may be attracted to the NICO Project because of food smells. In previous studies, Elders have indicated that the movements of the caribou have been affected by mining activities such as loud noise and fumes, but that the caribou may be adapting to the pollution (Dogrib Treaty 11 Council 2001). Whatì interview participants said that caribou migration routes have changed, elaborating that while there used to be a caribou trail between Kwejinne Lake and Russell Lake, the caribou now travel in many different directions and are spread out (Section 5.3.2.6).

The NICO Project will reduce less than 0.1% of the 2010 baseline caribou study area. The cumulative direct disturbance from the NICO Project and previous, existing, and future developments is predicted to be a little more than 0.2% relative to reference conditions. A measurable change in the abundance and distribution of caribou is predicted within 15 km of the anticipated mine site of the NICO Project and 1 to 5 km of other active developments (e.g., NPAR, and other winter and all-season roads), which will likely influence the availability of animals for hunting. The application of the NICO Project is expected to decrease good and high quality habitat by 0.4% relative to 2010 baseline conditions. Future developments are expected to decrease good and high quality habitat by 1.0% relative to the application case. The cumulative loss of good and high quality habitat from reference conditions to the future case is expected to be 6.1%; therefore, the decrease in the availability of caribou for harvesting from NICO-Project related effects is predicted to be within the range of baseline values (i.e., people that harvest caribou in the region should not observe a change in the availability of animals due to effects from the NICO Project, relative to current natural changes in population size).

Highway 3 and two existing all-weather roads provide access to a small amount of area within the winter range. Access is less limited in the winter because existing winter roads pass through the caribou study area (Figure 8.5-1). Winter roads are typically open from mid-December to mid-April (DOT 2011). Snow machines can access the study area through existing trails and along winter roads before they are open and after they close to vehicle traffic. The construction of the NPAR, and the Proposed Tłįchǫ Road Route will provide year-round access by vehicles to the region. Fortune will not permit hunting at the NICO site or by staff and contractors on the NPAR road while travelling to and from the site; however, the Proposed Tłįchǫ Road Route as well as the NPAR may still be used to hunt caribou.

During traditional knowledge interviews, participants indicated that hunting of caribou occurs throughout the RSA. Gamètì interview participants indicated that people might still hunt caribou in the NICO Project when the NICO Project is completed (Section 5.3.2). Whatì interview participants identified several caribou migration routes within the RSA including 2 routes that overlap the LSA and NICO Project (Section 5.3.2).

Currently in the NWT, caribou are managed mostly by controlling the hunting season and the per-person harvest for resident and non-resident hunters (ENR 2010b). Non-resident hunters in the NWT require the services of an outfitter to hunt big game, and there are no outfitting camps in the vicinity of the NPAR or Proposed Tłįchǫ Road Route. The hunting rights of Aboriginal people in the NWT are based on traditional use and are different from those of other hunters. Hunting by many Aboriginal people is managed in part by land claim agreements (in this case the Tłįchǫ Land Claim Agreement). Hunting by other groups may also be affected by the provisions in the Tłįchǫ Land Claim, through the Tłįchǫ Government and the Wek'èezhii Renewable Resource Board.

In January 2010 the GNWT implemented a complete ban on caribou hunting in a new no hunting conservation zone established north of Yellowknife where the Bathurst caribou herd resides during the winter. The no hunting zone includes the area between the existing Tłįchǫ winter road to Gamètì east to the Hoarfrost River in the East Arm, and north to Nunavut (ENR 2010c). This hunting ban has since been modified to a limited harvest of Bathurst caribou for aboriginal hunters, through an agreement with the Tłįchǫ Government, the GNWT, and the Wek'èezhii Renewable Resources Board (see ENR 2011b for the most recent status of this agreement). These restrictions will extend at least until the winter of 2012/2013.

A study on the Tibbitt-to-Contwoyto Winter Road reported that hunting was the most common land use along the road, followed by fishing, sightseeing, and camping (Ziemann 2007). Considering that the caribou hunting season is between 15 August and 30 April in the NWT (ENR 2010b), and that caribou are only present in the study area in winter, construction of the NPAR and Proposed Tłįcho Road Route would likely provide some increased access over existing winter roads (including the winter access road to the NICO Project) with regards to access for harvesting caribou (particularly with regards to the duration of access). Should harvesting on the Proposed Tłįchǫ Road Route and NPAR reach a level of concern, the Tłįchǫ Government or the Wek'èezhii Renewable Resources Board could enact regulations to control the harvest. For example, further restrictions could be placed on hunting seasons, bag limits for resident harvesters, and a no-hunting corridor could be implemented, similar to that currently in place for the Ingraham Trail. Subsequently, the number of caribou harvested in the winter range from improved access due to the NPAR and Proposed Tłįchǫ Road Route is predicted to be within or approach the upper limits of baseline values (in the absence of a caribou hunting ban).

8.6 Residual Effects Summary

8.6.1 Habitat Quantity and Fragmentation

The total area of the NICO Project footprint (including the NPAR) is estimated to be 485.4 ha; however, because the NICO Project Lease Boundary was used in the analyses, and the width of the NPAR had to match the raster cell size (200 m) in the land cover classification, the estimated NICO Project footprint for analysis is 1860 ha. The NICO Project will reduce less than 0.1% of the 2010 baseline caribou study area (i.e., winter range below the treeline). Previous and existing developments have removed 0.2% of habitat within the winter range relative to reference conditions. The combined loss of all habitats in the winter range from the Proposed Tłįchǫ Road Route and Taltson Hydroelectric Expansion Project (future case) is less than 0.1%. The cumulative direct disturbance from the NICO Project and previous, existing, and future developments is predicted to be a little more than 0.2% relative to reference conditions. Although progressive reclamation will be integrated into mine planning as part of Fortune's design for closure policy, subarctic ecosystems are slow to recover from disturbance. The Flooded Open Pit, constructed wetlands, Seepage Collection/Surge Ponds, and ditches will be permanent and local features on the landscape, covering approximately 84 ha.

Under reference conditions, the winter range of the Bathurst caribou herd is mainly composed of coniferous cover (28%), deep water (23%), and burns (22%). The shrub land cover type makes up about 7% of the winter range. Bryoids (wetlands) and bog/fen complexes (treed and herbaceous wetlands) compose about 8% of the landscape, while broadleaf and mixedwood (deciduous) habitats constitute 4% of the winter range. Open and sparsely vegetated bedrock areas represent 6% of the study area. Human development (i.e., communities) composes less than 0.1% of the study area. Preferred habitats by caribou on the winter range include coniferous forest, and bog/fen, and bryoid land cover types.

Previous and existing human developments in the study area have resulted in small reductions of habitat for caribou. Under 2010 baseline conditions, the largest decline in area since reference conditions has been bedrock cover (0.4%) and broadleaf forest cover (0.4%). With the application of the NICO Project, the area per habitat type declines by less than 0.1%. The largest incremental decline from future developments (Proposed Tłįchǫ Road Route and Taltson Hydroelectric Expansion Project) is expected to be 0.1% of coniferous and mixedwood habitats. The cumulative decrease in any particular land cover type from the NICO Project and previous, existing, and future developments is expected to be no larger than 0.5%, and bedrock and broadleaf habitats are affected most. Decreases in water (ice) are due to the temporary disturbance from winter roads.

Previous and existing human developments on the landscape also have contributed to small changes in the configuration of caribou habitat (i.e., fragmentation of habitat). From reference to 2010 baseline conditions, the largest decline in the number of patches per habitat type was 0.1% for bog/fen, broadleaf, mixedwood, and shrub habitats, and the largest increase in mean distance to nearest neighbour was 0.1% for bogs/fens. With the application of the NICO Project, the number of patches per habitat type declines by less than 0.1%, and the mean distance to nearest neighbour decreased by less than or equal to 0.2%. Under the future scenario, the incremental decline in number of patches for a given habitat will be less than 0.1%, except for burns, which is expected to increase by 0.5%. Overall, the magnitude of the cumulative change in the configuration of each habitat type from the NICO Project and previous, existing, and future developments is expected to be no larger than 1.7%.

8.6.2 Habitat Quality, Behaviour, and Movement

In addition to direct habitat effects, changes to habitat quality from the NICO Project and other developments have the potential to indirectly affect the population size and distribution of caribou, through altered movement and behaviour of individuals. A RSF was developed for the caribou study area using satellite and global positioning system collar data from 1996 through 2009, a human development database, and a vegetation classification (EOSD). Analysis completed during generation of the RSF indicated that the current extent of human development in the study area did not statistically influence the distribution and habitat selection of caribou (Appendix 8.II). Nevertheless, the objective of this section of the DAR was to estimate the potential incremental and cumulative changes in caribou habitat from the NICO Project and other developments using a set of disturbance coefficients and zones of influence that were based on information from empirical studies.

The amount of preferred habitat (i.e., high and good quality habitats) for Bathurst caribou in the winter range decreased by 5.1% from reference to 2006 baseline conditions. Most of the decline in habitat quality was associated with the increasing number of exploration sites on the landscape. Relative to 2006 baseline conditions, there was a 0.3% increase in good and high quality habitat in 2010. This is likely due to the decrease in the number of active mineral exploration camps in the caribou study area. The application of the NICO Project is expected to decrease good and high quality habitat by 0.4% relative to 2010 baseline conditions. Future developments (Proposed Tłįchǫ Road Route and Taltson Hydroelectric Expansion Project) are expected to decrease good and high quality habitat by 1.0% relative to the application case. The cumulative loss of good and high quality habitat from reference conditions to the future case is expected to be 6.1%.

The distance for noise attenuation to background for mining operations (including blasting) and the Airstrip is 3.3 km and 25.8 km, respectively (Appendix 8.III; Table 8.III.9-2). Disturbance from blasting is expected to occur once per day during operations. Caribou have been observed to have adverse reactions to low-flying aircraft (Calef et al. 1976; Harrington and Veitch 1991; Maier et al. 1998) and other loud noises (Bradshaw et al. 1997).

Aircraft are anticipated to be used for medical emergencies and the transport of some goods to site, during operations (i.e., the annual volume of aircraft traffic is expected to be low [Appendix 8.III]). Noise associated with the Airstrip will be infrequent and limited to take-off and landings (about 5 minutes), whereas the frequency of noise levels from mining operations are continuous.

During construction, approximately 2200 truck loads will be delivered to the NICO site during the winter road season. This amounts to approximately 63 return trips per day over an average 70 day (10 week) winter road season. During operations, an estimated 5 to 9 trucks per day are anticipated to travel along the NPAR and Proposed Tłįchǫ Road Route. Noise from the NPAR, existing winter roads, and the Proposed Tłįchǫ Road Route is expected to diminish to background noise levels within 0.9 km. The potential noise effects associated with existing winter roads and the NPAR during construction are temporary (limited to 8 to 12 weeks). During operations, noise from vehicles associated with NICO Project along the NPAR and Proposed Tłįchǫ Road Route will occur year-round.

A measurable change in the abundance and distribution of caribou is predicted within 15 km of the anticipated mine site of the NICO Project and 1 to 5 km of other active developments (e.g., NPAR, and other winter and all-season roads). Although these incremental changes to habitat quality from each active development in the winter range occur at the local to regional scales, the cumulative effect to the movement and behaviour of caribou extends to the population (i.e., beyond regional geographic extent). The duration of sensory disturbance effects on caribou from noise and the presence of people, vehicles, and aircraft traffic associated with the NICO Project is anticipated to occur over a 26 to 31 year period (i.e., effects should be reversed within 5 to 10 years following closure).

8.6.3 Effects on Behaviour, Energy Balance, and Calf Production

Costs for an encounter (i.e., a single disturbance event) with an active development were calculated as the sum of energetic costs for the initial flight response, additional movements, plus the cost of excitement. An increase in metabolic rates can also result from prolonged excitement from a disturbance event. It was assumed that animals were excited for a 12-hour period after an encounter. The total cost of disturbance from an encounter was estimated to be 1.69 MJ. Each encounter with disturbance was estimated to reduce the fecundity rate of female caribou by 0.00294 units. Thus, the incremental disturbance to a female caribou from the NICO Project is predicted to result in a 0.3% decrease in the fall calf:cow ratio relative to a reference condition.

For a landscape in which an individual in the population encounters an average of 40 sensory disturbance events in its winter range, the energetics model predicts that individual fecundity rates would be reduced by approximately 0.1176 units (i.e., a weight loss of 1.884 kg). Because only 55% of encounters elicit a flight response the overall change in fecundity rates was expected to be smaller, decreasing only 0.0647 units (i.e., a weight loss of 1.036 kg), which resulted in 7.1% decrease in the fall calf:cow ratio relative to a reference condition. The energetic model provides a conservative estimate of energy expenditure because the model assumes that individuals do not compensate for weight loss by increasing quality food intake following a disturbance event, and do not become habituated to similar disturbances. In addition, application of the energetic model to 40 hypothetical is likely an overestimate given that there were a maximum of about 30 active point disturbances in the caribou study area during baseline conditions. Caribou generally restrict their daily home range movements during mid to late winter, and should encounter fewer human disturbances.

Energetic costs of poor weather conditions (e.g., snow, freezing rain and ice) during the spring migration considered costs of travel and cratering (digging through snow) for food. The total cost from walking in deep snow and cratering was 53.2 MJ. Body mass loss in females from the extra cost of severe snow conditions was calculated to be 1.48 kg. Based on this loss in female body weight, calf survival is predicted to decrease by 0.148 units under a scenario of poor spring conditions, which results in a 26.6% decrease in the fall calf:cow ratio relative to a reference condition. Although human developments during fall and early winter movements in the winter range of the Bathurst herd may influence the demography of the herd, the effect was estimated to be about 3.5 times smaller than weather-related factors during the spring migration. In the occasional year with moderately severe spring conditions and 40 winter disturbance events, the predicted cumulative decrease in the fall calf:cow ratio is 19.5% relative to a reference condition. For the infrequent years with severe spring conditions and 40 winter disturbance events, the expected fall calf:cow ratio is 31.8% lower than the reference condition.

8.6.4 Related Effects to People

The decrease in the availability of caribou for harvesting from direct and indirect effects from the NICO Project is predicted to be within the range of baseline values. People should not observe a change in the availability of caribou due to effects from the NICO Project, relative to current natural changes in population size. Effects are expected to last from construction until 5 to 10 years after closure, and should be regional in geographic extent.

Construction of the NPAR and Proposed Tłįcho Road Route would likely increase the duration of access over existing winter roads (including the winter access road to the NICO Project) with respect to access for harvesting caribou. The spatial extent of incremental effects from the NPAR on access to caribou is regional, given the length of the road; however, the cumulative effects from the existing winter roads, NPAR, and Proposed Tłįchǫ Road Route are beyond regional in geographic extent as access extends over a greater area of the winter range. Although, the development of the Proposed Tłįchǫ Road Route and the NPAR during operations will increase access into the winter range during the entire year, harvesting of caribou would likely occur periodically (i.e., when caribou are on the winter range).

Should harvesting on the Proposed Tłįchǫ Road Route or NPAR reach a level of concern, the Tłįchǫ Government or the Wek’èezhii Renewable Resources Board could enact regulations to control the harvest. As such, it is expected that the incremental and cumulative increase in the harvest of caribou from the NPAR and Proposed Tłįchǫ Road Route will be within the range or approach the upper limits of baseline harvesting values. The duration of effects to caribou from increased access is predicted to be permanent as these roads will likely be maintained well beyond the temporal boundary of the assessment (i.e., more than 21 years [construction through closure]).

8.7 Residual Impact Classification

The purpose of the residual impact classification is to describe the residual effects from the NICO Project on caribou using a scale of common words (rather than numbers or units). The use of common words or criteria is a requirement in the TOR for the NICO Project (MVRB 2009). The following criteria must be used to assess the residual impacts from the NICO Project:

- direction;
- magnitude;

- geographic extent;
- duration;
- reversibility;
- frequency; and
- likelihood.

Generic definitions for each of the residual impact criteria are provided below.

8.7.1 Methods

In the DAR, the term “effect”, used in the effects analyses and residual effects summary, is regarded as an “impact” in the residual impact classification; therefore, in the residual impact classification, all residual effects are discussed and classified in terms of impacts to caribou.

The effects analyses and residual effects summary presented both the incremental and cumulative changes from the NICO Project and other developments on the environment, caribou, and use of caribou by people. Incremental effects represent the NICO Project-specific changes relative to baseline values in 2010. NICO Project-specific effects typically occur at the local scale (e.g., habitat loss due to the NICO Project footprint) or regional scale (e.g., combined habitat loss, noise, and sensory disturbance from NICO Project activities [i.e., ZOI]).

Cumulative effects are the sum of all changes from reference values through application of the NICO Project and reasonably foreseeable developments. In contrast to NICO Project-specific (incremental) effects, the geographic extent of cumulative effects is determined by the distribution of the caribou population. This is because the local and regional effects from the NICO Project and other developments overlap with the distribution of the Bathurst caribou population on their winter range.

For caribou, the assessment and classification of residual impacts was based on the predicted cumulative changes from reference conditions through application of the NICO Project and into the future case. The spatial boundary of the assessment is at the distribution of the Bathurst caribou herd during the winter, which is a requirement in the TOR (MVRB 2009). The incremental effects from the NICO Project relative to 2010 baseline conditions are also classified. Essentially, the only difference in the outcome of impact criteria between cumulative and incremental effects from the NICO Project is in the magnitude and geographic extent of impacts. The magnitude for cumulative impacts involves changes from reference conditions through application of the NICO Project and into the future case, while incremental impacts are based on changes from the NICO Project relative to 2010 baseline values. Cumulative impacts from the NICO Project and other developments influence the entire winter range of the Bathurst caribou herd. In contrast, the geographic extent of incremental impacts from the NICO Project may have a local or regional influence on the range of the Bathurst herd.

Effects statements are used to focus the analysis of changes to caribou that are associated with one or more primary pathways. The residual effects summary (Section 8.6) presents a numerical assessment for criteria such as magnitude, geographic extent, duration, and frequency. From the summary of residual effects, pathways associated with each effects statement are then classified using scales (categorical values such negligible, low, or high) for each impact criterion (e.g., magnitude).

To provide transparency in the DAR, the definitions for these scales were ecologically or logically based on caribou. Although professional judgement is inevitable in some cases, a strong effort was made to classify impacts using scientific principles and supporting evidence. The scale for the residual impact criteria for classifying effects from the NICO Project are specifically defined for caribou, and definitions for each criterion are provided in Table 8.7-1. More detailed explanations for magnitude, geographic extent, and duration are provided below.

Table 8.7-1: Definitions of Criteria Used in the Residual Impact Classification of Pathways for Effects on Abundance and Distribution of Caribou

Direction	Magnitude[a]	Geographic Extent	Duration	Frequency	Reversibility[b]	Likelihood
Negative: less favourable relative to baseline values **Positive:** an improvement over baseline values or conditions	**Negligible:** no predicted detectable change from baseline values **Low:** impact is predicted to be within the range of baseline values **Moderate:** impact is predicted to be at or slightly exceeds the limits of baseline values **High:** impact is predicted to be beyond the upper or lower limit of baseline values so that there is likely a change of state from baseline conditions	**Local:** small-scale direct and indirect impacts from the NICO Project (e.g., footprint, and dust deposition) **Regional:** the predicted maximum spatial extent of combined direct and indirect impacts from the NICO Project that exceed local-scale effects **Beyond Regional:** cumulative local and regional impacts from the NICO Project and other developments extend beyond the regional scale	**Short-term:** impact is reversible at end of construction **Medium-term:** impact is reversible at end of closure **Long-term:** impact is reversible within a defined length of time (e.g., animal life spans) beyond closure	**Isolated:** impact confined to a specific discrete period **Periodic:** impact occurs intermittently but repeatedly over the assessment period **Continuous:** impact will occur continually over the assessment period	**Reversible:** Impact will not result in a permanent change of state of the population compared to "similar" environments not influenced by the NICO Project **Irreversible:** impact is not reversible (i.e., duration of impact is unknown or permanent)	**Unlikely:** the impact is likely to occur less than one in 100 years **Possible:** the impact will have at least one chance of occurring in the next 100 years **Likely:** the impact will have at least one chance of occurring in the next 10 years **Highly Likely:** the impact is very probable (100% chance) within a year

[a] baseline includes range of predicted values from reference conditions (no development) through 2010 baseline conditions.

[b] "similar" implies an environment of the same type, region, and time period.

8.7.1.1 Magnitude

Magnitude (i.e., intensity of the impact) for NICO Project-specific (incremental) effects is scaled to the expected change (quantified or qualified) from 2010 baseline conditions to application of the NICO Project. Magnitude for cumulative effects is scaled to the expected quantified and/or qualified change from reference conditions (no development) through application of the NICO Project and reasonably foreseeable developments. Baseline conditions represent the historical and current environmental selection pressures that have shaped the observed patterns in caribou. Environmental selection pressures include both natural (e.g., weather, changes in gene frequencies, predation, and competition) and human-related factors (e.g., mineral development, traditional harvest, and sport hunting).

Depending on which selection pressures are currently driving changes to caribou and the system, baseline conditions typically fluctuate within a range of variation through time and space. The fluctuations are generated by changes in natural factors (natural variation) and variation associated with human influences. Relative to ecological time and space, baseline conditions are in a constant state of change due to the pushing and pulling of environmental selection pressures. Thus, baseline conditions can be thought of as a distribution of probability values, and the location of the value (e.g., middle or ends of the distribution) is dependent on which environmental factors are currently playing a key role in the trajectory of the Bathurst caribou population.

The approach used to classify the magnitude of changes in measurement endpoints (and related impacts) was based on scientific literature and professional opinion, and incorporated conservatism. Other environmental assessments often use the universal effect size approach for categorizing magnitude such as negligible changes (0 to 10%), small changes (10 to 25%), and medium changes (25 to 40%) (Munkittrick et al. 2009). Ideally, effect threshold values would be known, and measurement endpoints could be quantified accurately with a high degree of confidence; however, little is known about ecological thresholds, and biological parameters are typically associated with large amounts of natural variation; therefore, the classification of magnitude included a level of conservatism so that the impacts would not be underestimated.

The definition of magnitude provided in Table 8.7-1 is applicable for more qualitative results (e.g., impacts on caribou movement and behaviour, and related impacts to people). For quantitative analyses and results (e.g., loss and fragmentation of habitat, and changes to habitat suitability), the following definition for magnitude is applied:

- negligible: less than a 1% change from the NICO Project relative to baseline values;
- low: 1 to 10% change from the NICO Project relative to baseline values;
- moderate: greater than 10 to 20% change from the NICO Project relative to baseline values; and
- high: more than 20% change from the NICO Project relative to baseline values.

The proposed scale is consistent with the 20% rule for the severity of effects from chemical exposure on varying spatial scales of ecological effects (i.e., a 20% change in a measurement endpoint constitutes an ecological effect) (Suter et al. 1995). The scale is also consistent with and below thresholds identified by empirical and theoretical work on the relationship between loss of suitable habitat and the likelihood of population decline (Andrén 1994, 1999; Fahrig 1997; Mönkkönen and Reunanen 1999; Flather and Bevers 2002). These studies suggested that critical thresholds for changes in rates of population parameters in non-tropical bird and mammal species occur between 10% and 60% of original habitat. In other words, a measurable decrease in species abundance and diversity may be observed when the amount of suitable habitat that is lost exceeds a threshold value of 40%. In a recent review, Swift and Hannon (2010) found that most empirical studies demonstrated negative effects on insects, plants, birds, and mammals when the amount of habitat lost from the landscape was greater than 70%.

8.7.1.2 Geographic Extent

Geographic extent is the area or distance influenced by the direct and indirect effects from the NICO Project, and is different from the spatial boundary (i.e., study area) for the effects analysis and impact assessment. The study area for the effects analysis represents the maximum area used for the assessment and is related to the spatial distribution and movement (i.e., population boundary) of the Bathurst caribou herd during the winter (Section 8.1.3.2).

However, the geographic extent of impacts can occur on a number of scales within the spatial boundary of the assessment. As defined in Table 8.7-1, geographic extent for classifying impacts is based on 3 scales: local, regional, and beyond regional. Local-scale impacts mostly represent incremental changes to caribou population size and distribution that are directly related to the NICO Project footprint and activities (e.g., physical disturbance to vegetation [habitat]).

Changes at the regional scale are largely associated with the predicted maximum extent of incremental impacts from the NICO Project on caribou (i.e., ZOI), such as changes to habitat quality that occur beyond the local scale (e.g., more than 1 km from the NICO Project); however, at the scale of the population, the cumulative local and regional impacts from the NICO Project and other developments, and natural factors are beyond regional (which is the caribou study area or spatial boundary for the assessment). Local and regional scale impacts from several developments extend over the winter range of the population (i.e., beyond regional). Cumulative impacts from the NICO Project and other developments also occur at the beyond regional scale for traditional and non-traditional use of caribou.

8.7.1.3 Duration

Duration has 2 components. It is the amount of time between the start and end of a NICO Project activity or stressor (which is related to NICO Project development phases), plus the time required for the impact to be reversible. Essentially, duration is a function of the length of time that caribou are exposed to NICO Project activities, and reversibility.

By definition, impacts that are short-term, medium-term, or long-term in duration are reversible. NICO Project activities may end at closure, but the impact on caribou may continue beyond NICO Project closure. Some impacts may be reversible soon after removal of the stressor, such as effects on air quality from power generation and equipment operation (e.g., medium-term impact).

For caribou, the amount of time required for the impact to be reversed (i.e., duration of the effect) is presented in context of the number of life spans that caribou may be influenced. The anticipated duration of effects on caribou are then used to determine the number of human generations that may be affected by the related changes to traditional and non-traditional land use practices (e.g., caribou harvesting). In this manner, the impact assessment links the duration of NICO Project impacts on caribou to the amount of time that human use of ecological resources may be influenced.

For impacts that are permanent, the duration of the effect is determined to be irreversible. An example of an irreversible impact includes the localized loss of vegetation and habitat due to the Flooded Open Pit, constructed wetlands, Seepage Collection/Surge Ponds, and ditches.

8.7.2 Results

Direct incremental impacts from the NICO Project footprint (i.e., habitat loss) are local in geographic extent. The magnitude of incremental impacts from the NICO Project footprint on the Bathurst caribou population is predicted to be negligible (i.e., the NICO Project will alter 0.1% of the winter range); however, individuals from the Bathurst population may interact with other developments and activities in the study area. Therefore, the cumulative impacts from direct habitat loss and fragmentation from the NICO Project and other developments on population size and distribution are expected to be beyond regional in geographic extent (Table 8.7-2). Cumulative impacts from direct habitat loss from the NICO Project and previous, existing, and reasonably foreseeable future developments is expected to be 0.2% of the winter range (negligible magnitude). Direct impacts from the NICO Project will be continuous over the duration of the assessment period.

Although progressive reclamation will be integrated into mitigation and management plans for the NICO Project, subarctic terrestrial ecosystems are slow to recover from disturbance. In addition, not all the areas for the NICO Project will be reclaimed. The Flooded Open Pit, constructed wetlands, Seepage Collection/Surge Ponds, and ditches will be permanent features on the landscape (i.e., not reversible within the temporal boundary of the assessment) and will cover approximately 84 ha (Table 8.7-2). Values for incremental and cumulative habitat loss from development in the winter range are well below the 40% threshold value for habitat loss associated with expected declines in bird and mammal species (Andrén 1994, 1999; Fahrig 1997; Swift and Hannon 2010). The magnitude of incremental and cumulative impacts to the Bathurst caribou population from direct habitat loss and fragmentation is predicted to negligible (Table 8.7-2).

Development of the NICO Project is expected to cause indirect changes to the amount of different quality habitats for the Bathurst caribou herd. These changes are expected to result from the combination of noise and other sensory disturbances from the NICO Project, and are regional in geographic extent (Table 8.7-2). Based on the estimated ZOI from the literature, habitat quality is predicted to decrease within 15 km of the anticipated mine site of the NICO Project, within 5 km of the NPAR, and 1 to 5 km for other developments in the winter range. Noise levels from general mining operations and aircraft should reach background levels within 3.3 km and 26 km of the NICO Project, respectively. Sensory disturbance from vehicles travelling on the NPAR and Proposed Tłįchǫ Road Route are expected to diminish within 0.9 km of the road; however this impact will be regional in extent because of the length of the roads. All of these NICO Project pathways can combine with similar impacts from other developments in the region and decrease the amount of quality habitat in the winter range of the Bathurst population.

Direct and indirect impacts from the NICO Project (including the NPAR) are anticipated to decrease good and high quality habitat for caribou by 0.4% (negligible magnitude). Relative to reference conditions (no development), cumulative indirect impacts from the NICO Project and previous, existing, and reasonably foreseeable future developments are expected to reduce good and high quality caribou habitat by 6.1% (low magnitude) (Table 8.7-2). Indirect impacts from the NICO Project and roads will be continuous during operations, while indirect impacts from the NPAR and existing winter roads during construction will be isolated or periodic (i.e., limited to one or more winter seasons).

Table 8.7-2: Summary of Residual Impact Classification of Primary Pathways for Incremental and Cumulative Effects on Abundance and Distribution of the Bathurst Caribou Population and Related Effects to People

Pathway	Direction	Magnitude		Geographic Extent		Duration	Frequency	Reversibility	Likelihood
		Incremental	Cumulative	Incremental	Cumulative				
Physical footprint decreases habitat quantity and causes fragmentation	negative	negligible	negligible	local	beyond regional	long-term to permanent	continuous	reversible to irreversible	highly likely
Sensory effects (e.g., noise, presence, lights, smells) changes the amount of different quality habitats, and alters movement and behaviour of caribou	negative	negligible	low	regional	beyond regional	long-term	isolated or periodic (construction) to continuous	reversible	highly likely
Change in energetic costs from disturbance and displacement, which can influence survival and reproduction.	negative	negligible	low	regional	beyond regional	long-term	continuous	reversible	likely
Improved access for harvesting can affect caribou population sizes	negative	low to moderate	low to moderate	regional	beyond regional	permanent	periodic	irreversible	likely
Effects on population size and distribution changes the availability of caribou for traditional and non-traditional use	negative	low	moderate	regional	beyond regional	long-term	continuous	reversible	likely

The incremental impact to the energy balance of a female caribou from the NICO Project is predicted to result in a 0.3% (negligible magnitude) decrease in the fall calf:cow ratio relative to a reference condition. Cumulative impacts to the energy balance of female caribou from encountering 40 disturbance events on the winter range was predicted to decrease the fall calf:cow ratio by 7.1% (low magnitude) relative to a reference condition (Table 8.7-2). The frequency of impacts from human disturbance on the Bathurst herd is anticipated to be continuous relative to the life history of caribou (i.e., impact from human disturbance events on calf recruitment is continuous from one year to the next). In contrast, decreases in the calf:cow ratio of 13.2% (moderate magnitude) and 26.6% (high magnitude) were predicted for moderately severe and severe spring conditions, respectively; however, the frequency of impacts on the population from moderately severe and, in particular, severe spring conditions is expected to be periodic.

Impacts on the abundance and distribution of the Bathurst caribou population from changes in habitat quality, movement, behaviour, energy balance, and calf production from NICO Project activities are expected to be reversible within 5 to 10 years following closure (long-term). The estimated life span for a caribou is 11 to 15 years (Boulanger and Gunn 2007). Therefore, the duration of the long-term impact is 26 to 31 years or about 2 to 3 life spans for caribou.

With the development of the NPAR and Proposed Tłı̨chǫ Road Route, hunters would be able to make more use of vehicles (including snow machines) to access areas in the region, and for a longer duration of the hunting season relative to existing winter roads. The spatial extent of incremental and cumulative impacts from the NPAR and Proposed Tłı̨chǫ Road Route, and existing winter roads on the Bathurst caribou population from changes in harvesting pressure is expected to be regional and beyond regional, respectively (Table 8.7-2). Impacts to the population from harvesting will be limited to the winter season (i.e., periodic frequency) when caribou are on their winter range. Should harvesting on the Proposed Tłı̨chǫ Road Route or NPAR reach a level of concern, the Tłı̨chǫ Government or the Wek'èezhii Renewable Resources Board could enact regulations to control the harvest. Thus, it is expected that the incremental and cumulative increase in the harvest of caribou from the NPAR and Proposed Tłı̨chǫ Road Route will be within or approach the upper limits of baseline harvesting values (low to moderate magnitude). The duration of impacts to caribou from increased access is predicted to be permanent as these roads will likely be maintained well beyond the temporal boundary of the assessment (i.e., more than 21 years [construction through closure]) (Table 8.7-2).

During traditional knowledge interviews, participants indicated that hunting of caribou occurs throughout the RSA. Gamètì interview participants indicated that people might still hunt caribou in the NICO Project when the NICO Project is completed. Whatì interview participants identified several caribou migration routes within the RSA including 2 routes that overlap the LSA and NICO Project. Changes to the abundance and distribution of the Bathurst caribou population from development may negatively influence the traditional and non-traditional harvesting of caribou in the winter range. The predicted magnitude of the incremental decrease from the NICO Project on the amount of good and high quality habitat is 0.4%. Relative to reference conditions (no development), cumulative impacts from the NICO Project and previous, existing, and reasonably foreseeable future developments are expected to reduce good and high quality caribou habitat by 6.1%. Similarly, the magnitude of the cumulative impact from human-related disturbance events on calf recruitment is predicted to be low (7.1%). Therefore, the magnitude of changes to the harvesting potential of caribou from the incremental and cumulative impacts from the NICO Project and other developments are expected to be low and moderate, respectively (Table 8.7-2). The duration of the impacts to caribou is expected to last for 26 to 31 years, which is equivalent to about 1.5 human generations (assuming human generation time is 20 years). The impact is expected to be reversible in the long-term (Table 8.7-2).

8.8 Environmental Significance

8.8.1 Approach and Methods

The TOR requires that the developer "assess and provide an opinion on the significance of any residual adverse impacts predicted to remain after mitigation measures" (MVRB 2009). Environmental significance was used to evaluate the significance of incremental and cumulative impacts from the NICO Project and other developments on caribou and by extension, on the use of caribou by people. The evaluation of significance was based on ecological principles, to the extent possible, but also involved professional judgment and experienced opinion.

The classification of residual impacts on primary pathways provides the foundation for determining environmental significance from the NICO Project on the persistence of the Bathurst caribou population. Magnitude, geographic extent, and duration are the principal criteria used to predict significance (Section 6.6.3). Other criteria, such as frequency and likelihood are used as modifiers (where applicable) in the determination of significance.

Frequency may or may not modify duration, depending on the magnitude of the impact. Likelihood will also act as a modifier that can influence environmental significance. Environmental impact assessment considers impacts that are likely or highly likely to occur; however, within the definition of likelihood there can be a range of probabilities that impacts will occur. In special circumstances, the environmental significance may be lowered if an impact is considered to have a very low likelihood of occurring, and increased for impacts with a very high likelihood of occurring.

Duration of impacts, which includes reversibility, is a function of ecological resilience, and these ecological principles are applied to the evaluation of significance (Section 6.6.3). Although difficult to measure, resilience is the capacity of the system to absorb disturbance, and reorganize and retain the same structure, function, and feedback responses. Resilience includes resistance, capability to adapt to change, and how close the system is to a threshold before shifting states (i.e., precariousness).

The evaluation of significance for caribou considers the entire set of primary pathways that influence the assessment endpoint (e.g., persistence of the Bathurst caribou herd). The relative contribution of each pathway is used to determine the significance of the NICO Project on caribou, which represents a weight of evidence approach (Section 6.6.3). For example, a pathway with a high magnitude, large geographic extent, and long-term duration is given more weight in determining significance relative to pathways with smaller scale effects. The relative impact from each pathway is discussed; however, pathways that are predicted to have the greatest influence on changes to the persistence of caribou are also assumed to contribute the most to the determination of environmental significance.

Environmental significance is used to identify predicted impacts that have sufficient magnitude, duration, and geographic extent to cause fundamental changes to caribou. The following definitions are used for assessing the significance of impacts on the persistence of the Bathurst herd, and the associated continued opportunity for traditional use of caribou.

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 population persistence.

Significant – impacts are measurable at the population level and likely to decrease resilience and increase the risk to population persistence. A number of high magnitude and irreversible impacts at the population level (beyond regional scale) would likely be significant.

8.8.2 Results

The results predict that the incremental and cumulative impacts from the NICO Project and other developments should not significantly influence the persistence of the Bathurst caribou population. For all primary pathways influencing the abundance and distribution of the Bathurst population, cumulative impacts were determined to be beyond regional in geographic extent. For incremental impacts, the geographic extent of pathways ranged from local to regional. Local impacts to habitat were associated with the NICO Project footprint, while regional changes in habitat quality from noise and other sensory disturbance are expected to continuously influence individuals that travel through or occupy habitats within 15 km from the NICO Project. Regional impacts are also associated with periodic noise from aircraft (up to 26 km during takeoff and landing at the NICO Project site). Beyond regional impacts are related to the cumulative changes in habitat, movement, and behaviour from the NICO Project and other developments. The likelihood of the impacts occurring is expected to be likely to highly likely for all pathways (Table 8.7-2), 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 NICO Project.

Sensory disturbance impacts associated with influences of exploration, mining activities, and roads on the Bathurst caribou population are anticipated to be reversible over the long-term (26 to 31 years [3 caribou life spans]); however, the incremental and cumulative direct disturbance impacts to the Bathurst population from non-reclaimed portions of development footprints were assumed to be irreversible within the temporal boundaries of the assessment. Similarly, potential harvesting of caribou near the NPAR and Proposed Tłįchǫ Road Route will likely continue well beyond the temporal boundary of the assessment (i.e., permanent impact).

The magnitude for the 4 primary pathways impacting caribou ranged from negligible to moderate (Table 8.7-2). The magnitude of the cumulative impact from direct habitat loss associated with the NICO Project and previous, existing, and reasonably foreseeable future developments is expected to be about 0.2% of the winter relative to reference conditions. The relative amount of cumulative decrease in quality habitats from reference conditions to the future case in the study area is estimated to be 6.1%. The incremental impact from the NICO Project on direct and indirect habitat changes is less than or equal to 0.4% relative to 2010 baseline conditions. Relative to a reference condition, the change in energy balance to female caribou from the NICO Project is predicted to decrease the fall calf:cow ratio by 0.3%. The cumulative decrease in the fall calf:cow ratio is predicted to be 7.1% if female caribou encountered 40 disturbance events on the winter range. The magnitude of the impact from increased access is anticipated to be moderate and occur periodically (Table 8.7-2).

There is a moderate degree of uncertainty associated with the prediction of no significant adverse impacts on caribou, which is primarily related to the duration of impacts and the variability inherent in making long-term predictions in ecological systems. Confidence in the prediction is based on the consistent low effect sizes (i.e., magnitudes of change) that were determined from the incremental and cumulative effects analyses for habitat quantity and quality, and energy balance. Where uncertainty existed, model parameters were typically overestimated so that effects would not be less than anticipated. For example, the fragmentation analysis was completed on the NICO Project Lease Boundary, which is larger than the anticipated NICO Project footprint. The habitat quality model contained conservative estimates for spatial and temporal extent of ZOI from development to increase confidence that the assessment would not underestimate impacts. The energy balance model assumed that individuals did not compensate for weight loss by increasing quality food intake following a disturbance event and did not become habituated to similar disturbances. In addition, application of the energetic model to 40 hypothetical developments is likely an overestimate given that there were a maximum of about 30 active human-related point disturbances in the study area during baseline conditions. Caribou generally restrict their daily home range movements during mid to late winter, and should encounter fewer human disturbances.

There are natural environmental factors that operate over large scales of space and time that likely have greater influences on seasonal distributions of caribou relative to the incremental and cumulative impacts from the NICO Project and other developments. For example, some 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 can also influence the seasonal distribution of caribou by modifying insect levels, food abundance (primary productivity), snow depth and hardness, predator numbers (and alternative prey), and burns (Sharma et al. 2009; Vors and Boyce 2009). The energetic model in this assessment indicated that sensory disturbance from human developments can influence the demography of the Bathurst herd; however, the effect was estimated to be about 3.5 times smaller than weather-related factors during the spring migration (Section 8.5.4.2). Traditional knowledge also contends that fire frequency and intensity affects caribou numbers and distribution (Kendrick et al. 2005). A recent review by Adamczewski et al. (2009) also indicates that effects from the mines are limited and unlikely a major contributing factor in the decline of the Bathurst caribou herd relative to other environmental variables.

Overall, the weight of evidence from the analysis of the primary pathways predicts that the incremental and cumulative impacts from the NICO Project and other developments should not have a significant adverse impact on the persistence of the Bathurst caribou population. The current level of activity in the winter range and the implementation of environmental design features at the NICO Project should not negatively influence the resilience of the Bathurst caribou herd. The persistence of caribou herds during large fluctuations in population size indicates that the species has the capability to adapt to different disturbances and environmental selection pressures (Holling 1973; Gunderson 2000; Walker et al. 2004). Migration routes, and survival and reproduction rates appear to have the flexibility to respond to changes through time and across the landscape. Although caribou may be adversely affected by disturbance on their winter range, responses are generally less severe than other times of the year (e.g., post-calving) (Maier et al. 1998). This resilience in caribou populations suggests that the impacts from the NICO Project and other developments should be reversible and not significantly affect the future persistence of caribou populations. Subsequently, cumulative impacts from development also are not predicted to have a significant adverse effect on continued opportunities for the use of caribou by people that value these animals as part of their culture and livelihood.

8.9 Uncertainty

The purpose of the 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 impacts are not worse than predicted. Confidence in the assessment of environmental significance is related to the following elements:

- adequacy of baseline data for understanding current conditions and future changes unrelated to the NICO Project (e.g., extent of future developments, climate change, catastrophic events);

- model inputs (e.g., ZOI and disturbance coefficients from developments);
- understanding of NICO Project-related impacts on complex ecosystems that contain interactions across different scales of time and space (e.g., exactly how the NICO Project will influence caribou); and
- knowledge of the effectiveness of the environmental design features and mitigation for reducing or removing impacts (e.g., revegetation of wildlife habitat).

Like all scientific results and inferences, residual impact predictions must be tempered with uncertainty associated with the data and current knowledge of the system. It is anticipated that the baseline data is sufficient for understanding current conditions and future changes not related to the NICO Project, and that there is a moderate to high level of understanding of NICO Project-related impacts on the ecosystem. During the past 10 to 12 years, monitoring studies at operating diamond mines, and government and university research programs have provided good information on the Bathurst caribou population and development-related effects. Traditional knowledge studies and recommendations from elders about how to mitigate impacts from roads and other mine facilities has also increased during this time. This information increased the confidence in model inputs, caribou-development interactions, and the understanding of the success of mitigation policies and practices for limiting impacts to caribou; however, there remains a degree of uncertainty surrounding the degree to which some effects may occur (e.g., magnitude and duration).

It is understood that development activities will directly and indirectly affect habitat, and caribou behaviour and movement; however, long-term monitoring studies documenting the resilience of caribou to development and the time required to reverse impacts are lacking. Direct disturbance from previous, existing, and future development footprints was calculated to be about 0.2% of the regional habitat for the Bathurst caribou population. Yet there remains a high degree of uncertainty in the effectiveness of revegetation techniques for reversing the impact from direct changes to habitat.

Although quantitative and less biased than models based on expert opinion, RSF-based habitat maps have numerous sources of uncertainty; these 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). Further, habitat maps are a static view between a species and its environment, ignoring changes over time with ecological succession and natural disturbances such as climatic events; however, when considering the predictions from the NICO Project on caribou habitat, sources of uncertainty were reduced by using multiple habitat mapping methods (Burgman et al. 2005). For example, the assessment included both fragmentation analyses and the use of a RSF model, which together limit bias and imprecision in predictions.

To reduce uncertainty associated with changes in habitat quality, and altered movement and behaviour of caribou, conservative estimates of the ZOI and coefficients were applied to the RSF model, even though the analysis used to develop the RSF indicated that previous and current development on the winter range did not statistically influence caribou distribution and habitat selection. For example, a 500 m radius was used to estimate the area of the footprint for exploration sites (78.5 ha). This likely overestimates direct habitat loss as drilling activities are generally completed in the winter to avoid rutting from the rig and on-site vehicles (unless a heli-portable drill rig is used). A 200 m radius was used to estimate the area of historic remediated and non-remediated site footprints (e.g., Rayrock and Colomac mines).

Zones of influence were also applied to all active exploration sites in the winter range 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. Habitat suitability modifier coefficients (used for reducing habitat quality in the ZOI) with the greatest effect were applied in cases where zones of influenced overlapped, rather than using the average of 2 or more coefficients. The energetic model contained the following assumptions.

- Animals do not become accustomed (habituated) to repeated encounters with similar types of disturbances. Thus, each time an individual encounters and reacts to a disturbance (e.g., drill rig or helicopter), it has the same response, which is to run, become excited, and lose body weight.
- Reductions in body weight from encounters with development are not compensated for by an increase in food intake. In other words, once an animal loses weight from an encounter with a development, the individual does not gain back the weight (during the winter) by increasing the amount or quality of food eaten.

All of these attributes provide confidence that the assessment has not underestimated the environmental significance of the incremental and cumulative impacts from the NICO Project and other developments on caribou, and the people that value caribou for their livelihood.

8.9.1 Previous and Reasonably Foreseeable Developments

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 such as factors related to climate change (Walther et al. 2002). Predicting effects from past developments such as historic remediated and non-remediated sites also contains uncertainty.

The removal of physical hazards to people and wildlife at the Rayrock and Colomac mines was one objective of permanent closure for both mines. During closure and reclamation, the town sites were demolished, mine buildings were removed, the tailings areas were covered, the shafts were capped, and landfill sites were isolated and stabilized, garbage collected and removed, and all slopes prone to erosion were stabilized or are monitored annually (INAC 2010 a, b, internet sites). The Rayrock mine was remediated between 1996 and 1997, and long-term monitoring data have indicated that caribou in the area have the normal range of radionuclides for the NWT, very little risk remains to humans from radionuclides, and downstream water quality is not affected by the former mine (INAC 2010a, internet site). Remediation at the Colomac site was initiated in 2008 and is still ongoing. The water quality is improving; however it will be continued to be monitored until all remediation is complete in 2011 (INAC 2010b).

Reasonably foreseeable developments such as the Proposed Tłįchǫ Road Route, Taltson Hydroelectric Expansion Project, North Arm National Wildlife Area, and East Arm National Park also generate uncertainty in impact predictions. The Proposed Tłįchǫ Road Route will be an all-weather road linking Highway 3 with Gamètì and would pass through the Bathurst winter range. The magnitude of incremental changes to caribou habitat quantity and quality from the Proposed Tłįchǫ Road Route was predicted to be negligible to moderate. Most impacts from the Proposed Tłįchǫ Road Route should be associated with regional changes in habitat quantity and quality, and the potential to increase hunting pressure on caribou.

The Taltson Hydroelectric Expansion Project will be a transmission line linking the Twin Gorges hydroelectric station on the Taltson River with the existing and proposed mines north of Great Slave Lake. The transmission line would be about 700 km long. Infrastructure required for the Taltson Hydroelectric Expansion Project includes the placement of transmission towers, several substations, and the clearing of a 30 m corridor in areas where trees have the potential to interfere with the transmission line. The magnitude of incremental changes to caribou habitat quantity and quality from the Taltson Hydroelectric Expansion Project was predicted to be negligible to low. Most impacts from the Taltson Hydroelectric Expansion Project should be associated with localized changes in movement and behaviour of caribou during the construction phase. In March 2011, Dezé Energy filed a letter to the MVRB requesting more time to review the project and NWT market for power.

The proposed North Arm National Wildlife Area or Kwets`oòtłàà includes a 660 km^2 combination of mainland shoreline, numerous islands, and water located in the northern end of the North Arm of Great Slave Lake, and adjacent to the community of Behchokǫ̀. In June of 2010, the Canadian Wildlife Service agreed to sponsor this area as a candidate National Wildlife Area. This area is currently at Step 4 of 8 in the Protected Area Strategy Process, where a formal request for interim protection has been made with the Federal government. Overall, the proposed North Arm National Wildlife Area would be beneficial to the caribou from a conservation perspective.

The proposed national park at the East Arm of Great Slave Lake is representative of the North Western Boreal Uplands, and would include McLeod Bay, Reliance, Pike Portage, the Lockhart River, and Artillery Lake at the East Arm of Great Slave Lake. Although there have been some recent advances in the Park proposal, the concept is now over 40 years old and the East Arm National Park may not be created until the NICO Project is well into the operations phase. There is also uncertainty in predicting the status of the existing fishing and hunting lodges and camps in the proposed park. The assessment assumes that the existing lodges would no longer allow hunting, but would remain as tourist lodges. Overall, the proposed East Arm National Park would likely be beneficial to caribou from a conservation perspective.

There are 4 additional reasonably foreseeable developments that could affect caribou population size and distribution, including the following:

- Nailii Hydro Project;
- Yellowknife Gold Project at the Discovery Mine site;
- Nechalacho Project at Thor Lake; and
- Damoti Lake Gold Project.

The Nailii Hydro Project would include a run-of-river hydro plant constructed on the La Martre River, downstream of the community of Whatì. The largest scale plan includes a 12 megawatt hydro facility connected to Whatì to reduce their dependency on diesel generated power, and a transmission line to the existing Snare Hydro Complex to distribute power to Behchokǫ̀ and Yellowknife. Surplus power could be made available to the NICO Project through a purpose-built transmission line. The transmission line from the Snare Hydro Complex to Yellowknife is within the range of the Bathurst caribou herd, and caribou have been observed to browse and cross under this transmission line. Considering the abundance of non-forested bedrock and open forest in the Taiga Shield, the right-of-way for a transmission line does not create new or unfamiliar habitat. Most impacts to caribou from the Nailii Hydro Project would likely be associated with construction, which could be mitigated by avoiding constructing in seasons when caribou are present, or through a flexible construction schedule to avoid concentrations of caribou. The hydro development near Whatì would not be within the current winter range of barren-ground caribou. As a run-of-river project, vegetation loss would be largely limited to the infrastructure footprint.

Impacts from the Yellowknife Gold Project and the Nechalacho Project (Avalon Rare Metals Inc.) are difficult to anticipate, but may be negligible to low in magnitude and may specifically impact the behaviour and movement of animals in their autumn and winter ranges. The Yellowknife Gold Project is located 90 km north of the City of Yellowknife on the former Discovery Mine site, an existing contaminated area (Tyhee 2010, internet site). Access would be via the winter access road route and by air. Use of a pre-existing footprint and transportation infrastructure would be a key design feature that should limit the potential impacts to caribou.

The Nechalacho Project is a rare elements deposit. The footprint will be limited by using underground mining. This property will be located approximately 100 km southeast of the City of Yellowknife near Hearne Channel on the East Arm of Great Slave Lake. A key design feature for limiting the reduction in caribou habitat will be the use of Great Slave Lake for transportation. Mining products will be loaded into bulk transport containers, hauled to the seasonal dock facility along the north shore of Great Slave Lake and barged during the summer to a purpose-built hydrometallurgical plant, possibly located near the site of the old Pine Point mine on the south shore of Great Slave Lake (Avalon 2010, internet site).

The property for the Damoti Lake Gold Project is located approximately 20 km south of the Colomac Mine (Merc 2010, internet site), and will be accessed via the winter road to Colomac and Wekweètì. As the project is currently in the exploration stage and a mine plan has not yet been developed, there is uncertainty regarding the size and duration of the project; however, the impacts from this development on caribou may be similar to that predicted for the NICO Project.

8.10 Monitoring and Follow-Up

Upon approval of the NICO Project, a Wildlife Effects Monitoring Program will be implemented to limit effects to caribou and caribou habitat, determine the effectiveness of mitigation, and test impact predictions. The principal goal of the Wildlife Effects Monitoring Program is to provide information required for the NICO Project Environmental Management System to adaptively manage the NICO Project to protect caribou and caribou habitat. In addition, the Wildlife Effects Monitoring Program is designed to provide a process for regulators, communities, and other people interested in the NICO Project to participate in the development and review of wildlife effects mitigation and monitoring.

Specific objectives of the Wildlife Effects Monitoring Program include:

- provide information to test predicted impacts from the NICO Project DAR, and reduce uncertainty;
- implement environmental design features and mitigation to reduce the risks and disturbance to caribou and caribou habitat;
- determine the effectiveness of environmental design features and mitigation;
- incorporate local traditional and ecological knowledge, where applicable and available;
- propose action levels or adaptive management triggers that can be used as early warning signs for reviewing and implementing caribou mitigation practices and policies;
- design studies and data collection protocols that are consistent with other programs in the region; and
- consider existing regional and collaborative programs, such as Cumulative Impact Monitoring Program and the NWT Environmental Stewardship Framework.

More information regarding the Wildlife Effects Monitoring Program can be found in Appendix 18.II.

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